Health Consultation

Exposure Investigation

Blood Lead Levels in Jasper and Newton Counties, Missouri

Oronogo-Duenweg Mining Belt National Priorities List (NPL) Superfund Site,
Jasper County, Joplin, Missouri

EPA FACILITY ID: MOD980686281

Newton County Mine Tailings National Priorities List (NPL) Superfund Site,
Newton County, Granby, Missouri

EPA FACILITY ID: MOD981507585

October 30, 2024

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)
Office of Community Health Hazard Assessment
Atlanta, Georgia 30341

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR, which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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About ATSDR

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency of the U.S. Department of Health and Human Services (HHS). ATSDR works with other agencies and tribal, state, and local governments to study possible health risks in communities where people could come in contact with dangerous chemicals. For more information about ATSDR, visit the ATSDR website.

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List of Abbreviations and Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
BLL	blood lead level
BLRV	blood lead reference value
CCT	Corrosion Control Treatment
CDC	Centers for Disease Control and Prevention
CV	comparison value
DLS	Division of Laboratory Services
EI	exposure investigation
EPA	U.S. Environmental Protection Agency
FYR	Five Year Review
HUD	U.S. Department of Housing and Urban Development
IEUBK	Integrated Exposure Uptake Biokinetic
LPHA	Local Public Health Agency
MDHSS	Missouri Department of Health and Senior Services
MDOH	Missouri Department of Health
MRL	minimum risk level
NCMT	Newton County Mine Tailings
NHANES	National Health and Nutrition Examination Survey
NPL	National Priorities List
ODMB	Oronogo-Duenweg Mining Belt
OLHCHH	U.S. Department of Housing and Urban Development's Office of Lead Hazard Control and Healthy Homes
OMB	Office of Management and Budget
OSWER	EPA Office of Solid Waste and Emergency Response
PHA	Public Health Assessment
ppm	parts per million
SL	screening Level
TSMD	Tri-State Mining District
µg/dL	microgram per deciliter
XRF	X-Ray Fluorescence Spectrometry

1. Summary

The Agency for Toxic Substances and Disease Registry (ATSDR), in conjunction with Missouri Department of Health and Senior Services (MDHSS) and the U.S. Environmental Protection Agency (EPA), conducted an Exposure Investigation (EI) to evaluate people's exposure to lead in designated areas of Jasper and Newton Counties, Missouri. The area has been contaminated with lead, cadmium, and zinc from historic mining practices, and efforts to reduce exposures in the area have been ongoing since 1991. The EPA requested ATSDR conduct an EI as part of their five-year review process for the Oronogo-Duenweg Mining Belt (ODMB; in Jasper County) and Newton County Mine Tailings (NCMT) sites. In light of new scientific information resulting in more conservative recommended blood lead screening levels, there are concerns that historic residential clean-up levels, particularly in soils, may not be adequate to protect children.

This EI was designed to determine if residents living near the ODMB and NCMT sites were exposed to elevated levels of lead in their environment. ATSDR measured the blood lead level (BLL) of residents (children under 6 years old and women of childbearing age), and EPA and MDHSS measured lead in environmental samples in and around the residents' homes. The measured lead concentrations were compared to appropriate screening levels (SLs) in each media. A concentration above the SL does not necessarily mean that an adverse effect will occur, but it is an indication that the exposure should be further investigated and compared to the health effects documented in scientific literature.

There is no evidence of a threshold below which there are no harmful effects on cognition for children exposed to lead [EPA 2013]. Historically, screening levels for lead in blood have been based on the highest 2.5–5% of the population, and not on the potential for health effects to occur at the screening level. As exposure to lead in the environment has been reduced over time, the BLLs in the US population and the blood lead screening levels have also been reduced.

In 2021, CDC reduced its Blood Lead Reference Value (BLRV) from 5 micrograms per deciliter (µg/dL) to 3.5 µg/dL. The measured BLLs were compared to the current BLRV (3.5 µg/dL), which is based on the 97.5^{th} percentile of the most recent National Health and Nutrition Examination Survey (NHANES) blood lead distribution in children ages 1–5 years. Environmental samples were compared to EPA's site-specific remedial action level for lead in residential yard soil, EPA's action level for lead in public water systems, and the U.S. Department of Housing and Urban Development's (HUD's) SLs for household lead (in paint and dust wipes).

Based on the blood lead assessment and the lead measured in the environment, ATSDR made the following conclusions:

Conclusion 1: A higher percentage of children 1–5 years old sampled in this EI had BLLs above CDC's BLRV; however, this increase is driven by three children with BLLs above CDC's BLRV. The average BLLs measured near the ODMB and NCMT sites are similar to the average levels measured in a representative sample of children aged 1-5 of the U.S. general population.

Basis for conclusion: ATSDR compared the measured BLLs of residents in Jasper and Newton Counties to NHANES data for children 1–5 years old. Of the 28 participants between the ages of 1–5 years old with valid blood lead data, 3 (10.7%) had BLLs above CDC's BLRV (3.53, 4.12, and 4.90 µg/dL). This percentage is significantly higher than the 2.5% of BLLs above CDC's BLRV from the NHANES data. At the 50^{th} percentile, the BLLs measured in Jasper and Newton Counties were not significantly different than that of NHANES.

Conclusion 2: Higher blood lead levels measured in Jasper and Newton Counties are associated with contaminated residential soil, the self-reported condition of the home, and the use of home remedies.

Basis for conclusion: BLLs measured during this EI were positively correlated to measured lead concentrations in the soil in the yard, soil in the play area, and soil along the drip line of the home. Some responses to the questionnaire provided to community participants were also positively correlated with BLLs, including the condition of the home being less than good, the presence of chipping or peeling paint, and the use of home remedies. The significance of these findings is largely driven by BLLs above CDC's BLRV measured in 3 children. All 3 children had additional indicators of lead exposure (i.e., high levels of lead in residential soil samples, self-reported condition of the home being less than good, peeling and/or chipping interior paint, and use of home remedies).

Conclusion 3: Historic soil remediation strategies used in conjunction with other methods to reduce exposure in Jasper and Newton Counties, such as health education, may be effective in reducing exposure to lead to the current standards.

Basis for conclusion: No BLLs above CDC's BLRV were observed in homes that were below EPA's 1998 site-specific remedial action level for lead in residential yard soil. Individuals with BLLs above CDC's BLRV had the highest lead soil concentrations measured in this EI, with samples exceeding current and historic screening levels. Although it appears that soil remediation strategies along with health education and other efforts in the area are effective in reducing exposure to lead in Jasper and Newton Counties, the results of the EI are not intended to determine the efficacy of the remediation levels and do not apply to the general public.

Recommendations

- Local public health agencies (LPHAs), in cooperation with MDHSS through cooperative agreements with ATSDR and the EPA, should continue health education activities to reduce environmental exposure to lead in the community.
- MDHSS and LPHAs should continue to promote and offer access to blood lead testing for children and women of childbearing age in the area.
- EPA should continue to promote and offer access to lead-soil sampling for residential yards in the area and remediate residential yards with elevated lead in soil.
- EPA and MDHSS should continue to promote and offer access to lead dust and paint sampling for homes of children in the area with BLLs above CDC's BLRV.
- EPA, MDHSS, and LPHAs should continue to promote and offer access to private well testing, and Missouri Department of Natural Resources should continue to promote municipal water testing for lead and other associated heavy metal contaminants for homes in the area.

This health consultation report explains these conclusions. An easy-to-read summary is also available at [LINK]. If you have questions or comments, call ATSDR's regional office director, Erin Evans, at 913-551-7477 or our toll-free number at 1-800-CDC-INFO and ask for information on the Jasper and Newton Counties Missouri site.

2. Background

2.1 Statement of Issue and Purpose

In 1980, Congress established the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), informally called Superfund, to allow U.S. Environmental Protection Agency (EPA) to clean up contaminated waste sites across the United States. The Oronogo-Duenweg Mining Belt (ODMB) site, primarily in Jasper County, and Newton County Mine Tailings (NCMT) site in Newton County are two Superfund sites that have been contaminated with lead and other metals from historic lead mining, milling, and smelting practices [EPA 2004a, 2010]. The EPA has been characterizing and cleaning up areas within the two Superfund sites since 1991.

In August of 2022, as part of ATSDR's public health assessment (PHA) process and at the request of the EPA, ATSDR conducted an exposure investigation (EI) to measure and compare blood lead levels (BLLs) and environmental lead levels for participating women and children residing near the ODMB and NCMT sites. See Appendix A for a brief description of ATSDR's PHA process. This EI was a collaborative project between ATSDR, Centers for Disease Control and Prevention (CDC) Division of Laboratory Sciences (DLS), EPA, Missouri Department of Health and Senior Services (MDHSS), and local health departments (Joplin City, Jasper County, and Newton County, referred to as local public health authorities [LPHAs] below). The roles and responsibilities of each collaborative partner in the EI are listed below.

- **ATSDR**: ATSDR was responsible for designing the study protocol, recruiting participants, collecting blood, and reporting the study results. An ATSDR medical officer was responsible for developing the clinician education program and action plans for case management of participants with BLLs exceeding the CDC's blood lead reference value (BLRV). The BLRV is used to identify children who have more lead in their blood than other children, described in detail below.
- **CDC DLS:** CDC DLS was responsible for analyzing blood samples for lead.
- **EPA**: EPA was responsible for collecting, processing, and analyzing residential soils and drinking water from private residential wells. Samples were collected from participating households. The laboratory analysis was performed by EPA Region 7's Science and Technology Center.
- **MDHSS**: MDHSS was responsible for collecting and analyzing household dust, measuring lead in interior and exterior painted surfaces, and analyzing drinking water from municipal water supplies. Laboratory analysis for dust wipe and municipal water samples was performed by the Missouri State Public Health Laboratory.
- **LPHAs**: LPHAs are responsible for conducting case management for participants with BLLs above CDC's BLRV.

2.2 Site Description and Timeline

The ODMB and NCMT Superfund sites are part of the Tri-State Mining District (TSMD) which encompasses approximately 2,500 square miles of land in Kansas, Missouri, and Oklahoma. From 1850 to 1970, the TSMD was one of the foremost lead and zinc mining areas of the world. Mining and smelting operations were highest in the years from 1900 through 1950. Former mining and smelting operations contaminated soil, groundwater, surface water, and sediments with lead, zinc, and cadmium [ATSDR 1990, 2006].

ATSDR released a Preliminary Public Health Assessment (PHA) for the ODMB in 1990 and a PHA for the NCMT Site in 2006. PHAs evaluate hazardous waste sites to determine whether people could be harmed

by exposure to site-related substances. Both assessments concluded that the sites posed a public health concern due to human exposure to metals via ingestion and inhalation of contaminated groundwater, soil, and air [ATSDR 1990, 2006]. See Appendix B for a more detailed description of efforts to reduce exposure to lead in Jasper and Newton Counties and timelines for remedial actions taken at each site.

2.2.1 Changes to Lead Guidance Over Time

There is no evidence of a threshold below which there are no harmful effects on cognition for children exposed to lead [EPA 2013]. Historically, screening levels for lead in blood have been based on the highest 2.5–5% of the population, and not on health effects observed at the screening value. As exposure to lead in the environment has been reduced over time, so have the average BLLs in the US population and thus the blood lead screening levels. In 2021, CDC reduced the BLRV from 5 µg/dL to 3.5 µg/dL. This current level is based on the 97.5th percentile of the blood lead values among U.S. children ages 1–5 years from the 2015–2016 and 2017–2018 National Health and Nutrition Examination Survey (NHANES) cycles. Children with BLLs at or above the BLRV represent the top 2.5% of BLLs in the most susceptible population [ATSDR 2021].

As the blood lead screening levels have been lowered over time, the recommended concentration of lead in soil has also decreased. Guidance for lead in soil is based on EPA's Integrated Exposure Uptake Biokinetic Model for lead in children (lEUBK). The IEUBK predicts BLLS in young children (birth to 7 years of age) exposed to lead from several sources of exposure and via different routes. Initially EPA used the highest soil sample to compare to the lead screening level of 800 parts per million (ppm). Later the average soil sample was used for screening at 400 ppm. EPA currently recommends a regional screening level (RSL) for composite samples of 200 ppm or 100 ppm if an additional source of lead exposure is identified (e.g., lead water service lines, lead-based paint, non-attainment areas where the air lead concentrations exceed National Ambient Air Quality Standards [NAAQS]) [EPA 2024]. In the current version of the model (IEUBKv2), using 5 µg/dL as the 95th percentile target blood lead level and national default lead concentrations, predicts a soil lead concentration of approximately 200 ppm and a geometric mean blood lead level of 2.3 µg/dL [EPA 2024]. EPA has not evaluated the IEUBKv2 below 5 µg/dL [EPA 2024a]. See Appendix C for a more in-depth description of how lead screening for blood and soil have changed over time.

There is some uncertainty as to whether historic soil remediation levels for lead in Jasper and Newton Counties adequately protect human health. According to the Five-Year Reviews for the ODMB and NCMT sites, EPA will review blood lead and residential yard data to address the protectiveness of these historic action levels [EPA 2019, 2022].

Based on previous blood lead measurements in the community, Jasper County has historically had a higher incidence of children exceeding blood lead screening levels than Newton County and the state of Missouri. Blood lead levels in children have been reduced over time in both counties and the state of Missouri. See Appendix C for figures representing historic BLLs in Jasper and Newton Counties compared to the state of Missouri.

2.2.2 The Oronogo-Duenweg Mining Belt (ODMB) Superfund Site

Jasper County was added to the National Priorities List (NPL) in 1990 based on residential soils contaminated with lead, cadmium, and zinc from historic mining practices [EPA 1996]. The NPL is EPA's list of sites of national priority that have known or threatened releases of contaminants that may impact the environment and human health. In 1991, ATSDR, in partnership with the Missouri Department of Health (MDOH) now known as the MDHSS, initiated a lead and cadmium exposure study to determine if residents living in the Jasper County Superfund site area had blood lead and urine cadmium levels higher

than residents living in a comparison area. The final report, published in 1995, found that BLLs were significantly higher in the exposed group, and approximately 14 percent of children younger than 7 years of age at the site had BLLs exceeding 10 µg/dL. Urinary cadmium levels did not significantly differ between the control and study populations. Environmental exposure to soil in the area was the most important factor influencing the distribution of BLLs [ATSDR 1995]. In a separate assessment by EPA and MDOH, metal concentrations found at the Jasper County site were sufficient to pose potential health risks to individuals who lived within the Jasper County site, particularly those who ingested locally grown produce. Exposure to two metals, lead and cadmium, accounted for most of the risk posed by the site [EPA 1995].

EPA implemented major interventions in response to the 1995 report. By June 2000, they had remediated 2,288 residential yards to 500 ppm or lower depending on the time of remediation. In 2000, ATSDR and MDOH conducted a follow-up lead exposure study to determine whether the interventions had been effective in reducing the mean BLLs of children residing in the area. The final follow-up study report, published in 2002, found that educational and environmental interventions were effective in reducing mean BLLs [ATSDR 2002]. Only two percent of the children tested in 2002 had BLLs greater than 10 µg/dL. See Appendix B for a description of assessments, conclusions, and a timeline of efforts to reduce exposure to lead in Jasper and Newton Counties.

The initial assessment at this site showed an elevated risk of adverse effects for people living on soils or mine waste with lead levels exceeding 800 ppm or with cadmium levels exceeding 75 ppm. After adjusting the lEUBK model using appropriate site-specific information, the residential soil lead screening level was reduced to 400 ppm, which is the current EPA site-specific remedial action level for both Jasper and Newton Counties [EPA 2010]. See Appendix C for historic screening levels for lead in blood and soil.

The original site boundary of the ODMB covered about 270 square miles of western Jasper County and a small northwestern portion of the bordering Newton County. The site boundary remained unchanged until 2024 when it was expanded to include all of Jasper County based on the identification of additional areas of surface soil and groundwater contamination from historic mining [EPA 2024a]. The site boundary was expanded after EI data were collected.

2.2.3 Newton County Mine Tailings Superfund Site

Preliminary and confirmatory assessments from 1986–1995 have documented lead contamination in soil and groundwater in Newton County [EPA 2019]. Newton County was listed on the NPL on September 29, 2003, due to the disposal of large volumes of mining wastes scattered throughout Newton County from past mining operations. The site includes wastes in and around 14 mining camps located within approximately 300 square miles of Newton County [EPA 2010]. In ATSDR's 2006 PHA, the Newton County site was classified as a public health hazard for past, present, and future risk of long-term exposure to hazardous substances [ATSDR 2006]. These classifications were based on the following conclusions:

- Lead and cadmium contamination present in the groundwater at levels above health-based drinking water limits at the time the PHA was released.
- Some residential yards in all the subdistricts and Spring City area were found to have lead levels above site-specific removal action limits.
- High levels of contaminants are present at the source areas that have yet to be remediated; therefore, exposure may occur to remediation workers, trespassers, and others that may occupy or work around the source areas. Exposure could also occur if the area is developed or used for other purposes before it is completely remediated.

Significant response actions and cleanup activities taken to date have led to the excavation and replacement of residential yard soil at thousands of properties, the construction and installation of over 100 miles of new municipal water supply mains, the installation of over 100 individual deep aquifer private drinking water wells, and the removal and disposal of source material from thousands of acres. See Appendix B for a description of assessments, conclusions, and a timeline of efforts to reduce exposure to lead in Jasper and Newton Counties.

2.3 Health Impacts and Exposure to Lead in the Environment

Lead is a naturally occurring element in the Earth's crust and is present in environmental media, including water and soil. The general population may be exposed to lead in ambient air, foods, drinking water, soil, and dust. A major source of lead in the U.S. environment has historically been anthropogenic emissions to the atmosphere from combustion of leaded gasoline, which was phased out of use after 1973 and then banned in 1995 (with the exception of fuels for piston-driven aircraft) [ATSDR 2020]. Other anthropogenic sources of lead have included manufacture of and use of lead-containing products (e.g., lead-based paints, pigments, and glazes; electrical shielding; plumbing; storage batteries; solder; and welding fluxes); manufacture and application of lead-containing pesticides; combustion of coal and oil; and waste incineration. Deteriorating lead-based paints from weathered surfaces (which produce highly concentrated lead debris and dusts) in older housing stock (pre-1978) continue to be a source of childhood lead poisoning in the United States (CDC 1991, 2012d). The combination of corrosive water and lead pipes or lead-soldered joints can result in high lead water concentrations. Lead has also been found in a variety of other consumer products including storage batteries, solders, pottery glazes, leaded crystal glassware, cosmetics, hair dyes, jewelry, gun shot and ammunition, relic fishing sinkers, tire weights, and imported children's toys, traditional or folk remedies, and candy/food packaging. For adults, exposure to levels of lead beyond background is usually associated with occupational exposures. For children, exposure to high levels of lead is typically associated with living in areas contaminated by lead (e.g., soil or indoor dust in older homes with lead-based paint) [ATSDR 2020].

The effects of lead are the same for each route of exposure. While lead can affect almost every organ and system in the body, the nervous system is the main target for lead poisoning in children and adults. Children are more vulnerable to lead poisoning than adults because their nervous system is still developing. Children can be exposed to lead in their environment and before birth from lead in their mother's body. At low levels of exposure, lead can decrease mental development, especially learning, hearing and speech, intelligence, and behavior. Physical growth may also be decreased. A child who swallows large amounts of lead may develop anemia, severe stomachache, muscle weakness, and brain damage. Exposure to lead during pregnancy can result in premature births. Some effects of lead poisoning in a child may continue into adulthood [ATSDR 2020].

No acceptable BLL has been identified that is free from deleterious health effects in children from 1 to 5 years of age [ATSDR 2020]. As a result, children's BLLs should be kept as low as possible. CDC's BLRV, 3.5 µg/dL, is a screening tool to identify children who have higher levels of lead in their blood compared to the general US population. See Appendix C for more information on the BLRV. The reference value is not health-based and is not a regulatory standard. To learn more about CDC's updated recommendations on children's BLLs, please visit: https://www.cdc.gov/lead-prevention/hcp/clinical-guidance/index.html.

3. Community Description and Concerns

3.1 Community Demographics

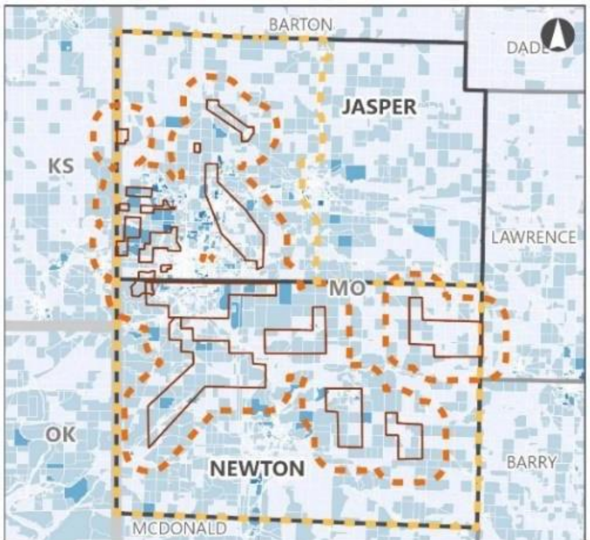
EI participants were selected from the western side of Jasper County and all of Newton County based on the location of the designated areas of contamination of the ODMB and NCMT sites at the time of the EI (See Figure 1). Demographics were separately shown for the 2-mile radius around the mining district and the larger recruitment area of the EI. After the EI was conducted, the ODMB site was expanded to include all of Jasper County; this expansion occurred due to the identification of additional areas in the county with contaminated soil and groundwater.

Figure 1: Demographics for Sensitive Populations within a 2-mile radius of Mining areas in Jasper and Newton Counties

Sensitive Populations

Jasper and Newton County, MO

Children Aged 5 and Younger



No. of Children 5 Yrs & Younger By Census Block

0 | 1 - 10 | 11 - 30 | 31 - 70 | 71 - 141

Mining District | 2-Mile Buffer | Recruitment Area

Females Aged 15 - 44

No. of Females 15 - 44 By Census Block

0 | 1 - 17 | 18 - 50 | 51 - 146 | 147 - 265

Mining District | 2-Mile Buffer | Recruitment Area

Demographic Statistics within 2 Miles of Site Boundary[4,5]

Measure	2010	2020	Change
Total Population	120,767	124,272	+2%
White Alone	109,276	103,445	-5%
Black Alone	2,202	2,362	+7%
Am. Indian/Alaska Native Alone	2,254	2,549	+13%
Asian Alone	1,362	1,690	+24%
Native Hawaiian & Other Pacific Islander Alone	197	466	+136%
Some Other Race Alone	1,608	2,464	+53%
Two or More Races	3,876	11,307	+191%
Hispanic or Latino[6]	4,293	6,263	+45%
Children Aged 5 and Younger	10,340	9,189	-11%
Children Aged 6 to 14	15,048	15,023	0%
Females Aged 15 to 44	24,098	24,584	+2%
Housing Units	52,507	54,154	+3%
Housing Units Pre 1950	10,482	9,583	-8%

Demographic Statistics within Recruitment Area[4,5]

Measure	2010	2020	Change
Total Population	151,213	156,096	+3%
White Alone	135,781	128,857	-5%
Black Alone	2,446	2,632	+7%
Am. Indian/Alaska Native Alone	2,847	3,311	+16%
Asian Alone	1,746	2,053	+17%
Native Hawaiian & Other Pacific Islander Alone	686	1,165	+69%
Some Other Race Alone	2,886	4,227	+46%
Two or More Races	4,822	13,854	+187%
Hispanic or Latino[6]	6,337	9,110	+43%
Children Aged 5 and Younger	12,962	11,623	-8%
Children Aged 6 to 14	18,997	19,385	+25%
Females Aged 15 to 44	29,902	30,452	+1%
Housing Units	65,088	67,178	+3%
Housing Units Pre 1950	13,459	12,008	-10%

Data Sources: [1]ATSDR, [2]ATSDR GRASP, [3]TomTom 2021Q3, [4]US Census 2020 Demographic and Housing Characteristics, **Notes:** [5]Calculated using area-proportion spatial analysis method, [6]Individuals identifying origin as Hispanic or Latino may be of any race. **Coordinate System:** Coordinate System used for all map panels is NAD 1983 StatePlane Missouri West FIPS 2403 Feet

ATSDR Agency for Toxic Substances and Disease Registry

GRASP Geospatial Research, Analysis, and Services Program

4. Methods and Sampling Data

4.1 Recruitment

Participants for the EI were recruited from the areas near the ODMB and NCMT Superfund sites' boundaries. ATSDR used previous site investigations and historic site sampling data provided by EPA Region 7 to identify areas where soil lead contamination is highest or suspected to be present. Eligible participants in the EI were children less than 6 years old and pregnant women or women of childbearing age (15–44 years). Ineligible participants included siblings of eligible participants that were at least 6 years old and people that were identified as living outside of the eligibility area but were tested as a public health service. Participation in the EI was voluntary and consisted of giving blood, answering a questionnaire, and consenting to have environmental samples collected at the participants' residence by EPA and MDHSS. See Appendix D for sampling protocols. Each participant, eligible and ineligible, received individual result letters. Blood results from ineligible participants were not included in the exposure investigation analysis.

4.2 Data Collection

Lead was measured in blood, household dust (collected using a surface wipe), paint, drinking water (from tap or well), and soil. During the EI, participants came to a central location in either Jasper or Newton County, gave a blood sample and were administered a questionnaire to document demographic, behavioral, occupational, and educational information. Dust, paint, water, and soil samples were collected from participants' households within 90 days of blood collection. See Appendix D for specific details of the methods used in this EI.

Due to the inability to contact participants and/or denied access to homes, environmental samples (i.e., soil, paint, dust, and water) were not collected at every household of EI participants. Soil samples were collected at roughly 70% of homes with blood lead data. Paint, dust, and water samples were collected at less than half of the homes with blood lead data. The lack of environmental sampling data limits the ability to determine the source of lead exposures in each home and the correlation of environmental samples to BLLs.

Blood

Venous draw blood lead sampling is the most reliable method for measuring recent and ongoing exposure to lead. Blood was collected by a certified phlebotomist with a medical officer present, using appropriate blood drawing protocols [CDC 2019]. Blood lead results reflect lead exposure from all sources and cannot identify a specific source of exposure.

A phlebotomist collected approximately 3 milliliters (mL) of blood from a vein of each participant who provided consent using 3 mL ethylenediamine tetra-acetic acid coated pre-screened evacuated tubes provided by the CDC DLS. Blood samples were returned to DLS on ice and refrigerated before analysis.

Lead Paint

MDHSS measured lead in paint using X-Ray Fluorescence (XRF) according to the U.S. Department of Housing and Urban Development (HUD) guidelines. The condition of the painted surfaces was recorded. A worst-case scenario evaluation was used to determine sample locations within each room. Samples were collected throughout the interior and exterior of the home, focusing on areas with the highest potential for lead exposure (deteriorating paint that was chipped or peeling). XRF measurements were

taken in the child's bedroom, kitchen, child's main play area, two exterior walls, and porch. In each area, the following were sampled: window components, door components, walls, cabinets, and floors that were painted or coated.

Dust Wipes

MDHSS sampled dust in homes according to HUD guidelines [HUD 2017]. Areas that have the most potential to be a hazard (i.e., near deteriorated paint or lead-paint hazards) were sampled to get the worst-case scenario. Surface wipe samples were obtained from the entryway, primary living area, kitchen, child's bedroom, and child's main play area. As many as nine samples and one blank were collected per household focusing on common points of exposure, such as porch floors, window troughs, and areas which children can easily access. Samples were analyzed by the Missouri State Public Health Laboratory.

Water

Drinking water samples were collected by the participants using municipal water and by EPA for participants using private well water. For municipal water, to evaluate the potential for exposure to lead in pipes and/or kitchen tap fixtures, a 250 mL sample was collected immediately after water was stagnant in pipes for an 8–18-hour period; this is typically first thing in the morning. For private well water, 500 mL was collected from the kitchen faucet at any time of day. EPA analyzed well-water samples and MDHSS analyzed municipal water samples in the EPA and State Public Health Laboratory, respectively.

Soil

Residential yard soil samples were collected by EPA over the course of several months. A rough sketch of the aerial view of the yard was made showing the division and indication of the yard areas into the following sample site categories: dripline, general yard (non-play area), play area/s and garden. Separate composite soil samples were collected from the general yard area within approximately 100 feet of the structure, dripline within three feet of structure walls, and primary play areas of the child. If a garden was present at the home, a composite sample was taken in the garden. The composite soil samples were analyzed by an EPA laboratory using a combination of XRF screening and fixed-laboratory confirmation analyses.

Questionnaire

ATSDR administered a questionnaire about daily activities related to exposure. The questionnaire, approved by the Office of Management and Budget (OMB 0923–0048), covered demographic, behavioral, occupational, and educational information of participants. Parents/guardians completed the survey for the child participants. The responses were used in the evaluation of blood lead results.

4.3 Laboratory and Data Analysis

Once all samples and data were collected, the analysis consisted of the following:

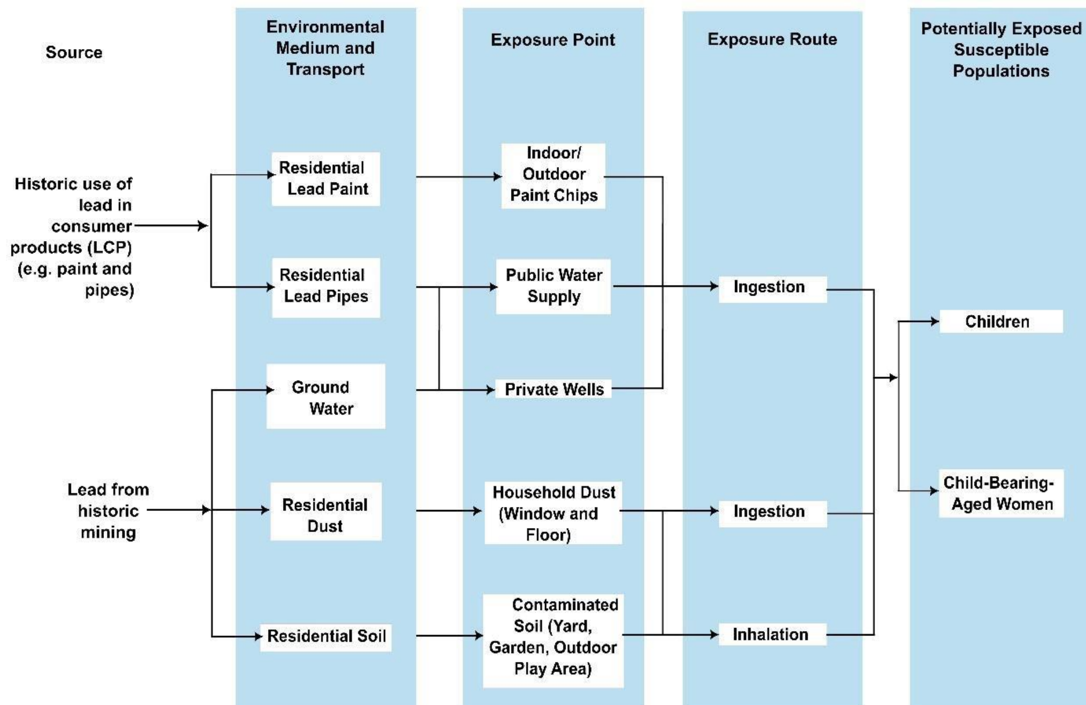
1. Participants BLLs were compared to the BLRV of 3.5 µg/dL.
2. Lead levels in environmental samples collected from participating residents' indoor and outdoor environments were compared to SLs from EPA and HUD.
3. Determine the association, if any, between lead levels in environmental samples (water, soil, dust, and paint), participants' responses to the questionnaire, and participants' BLLs.

5. Scientific Evaluations

5.1. Exposure Pathway Analysis

An exposure pathway describes how people in a community might come into contact with a site-related chemical. ATSDR evaluates exposure pathways to determine the potential for past, present, and future exposures to individuals living near contaminated areas. Figure 2 below is a conceptual site model that shows the different exposure pathways for lead in Jasper and Newton Counties.

Figure 2. Conceptual Site Model for Lead Exposure in Jasper and Newton Counties*†



*Dermal exposure plays a role for exposure to organic lead among workers but is not considered a significant pathway for the general population.

†Although all community members can be exposed, children (and the fetus exposed during pregnancy) are the most susceptible to effects from exposure to lead.

Historic mining is a major contributor to lead contamination of soil, groundwater, and indoor/outdoor dust in areas surrounding the ODMB and NCMT sites. Individuals can be exposed to lead in soil, groundwater, and dust via ingestion. Lead is contained in particles of dust and soil that can be inhaled and ingested in small amounts. Lead from soil is ingested by children playing in contaminated play areas or playing with toys that have been in contact with contaminated areas. Lead in soil and dust can also be brought into the home via contaminated shoes and clothing. Lead from the soil can leach into groundwater and be ingested via well water. Although municipal water is not contaminated with lead from historic mining practices, lead from pipes in older homes can be a source of exposure via ingestion of water.

The historic use of lead in paint can also add to the amount of lead in indoor/outdoor dust. Lead was a component of interior and exterior house paint up until 1978. In older homes with deteriorating lead

paint, individuals can be exposed through ingestion of paint chips or inhalation or ingestion of household dust.

5.2. Screening Analysis

As part of the EI process, ATSDR compared the measured concentrations of lead in each media to screening levels (SLs) provided by EPA and HUD, which are intended to protect the general public from negative health effects. A concentration above the SL does not necessarily mean that an adverse effect will occur, but it is an indication that the specific contaminant should be further investigated and compared to the health effects documented in scientific literature. Table 1 below shows the SLs for lead measured in each media. Table 2 shows the number of households that were sampled for lead in each media and the number and percent that exceeded the screening level. See Appendix E for details of each SL used in this EI.

Table 1. Lead Screening Levels Used in this Exposure Investigation*

Type of Sample	Screening Level	Reference	Method Detection Limits (MDLs)
Blood†	3.5 µg/dL— Children less than 6 years old and women of childbearing age 15–44 years old	CDC Blood Lead Reference Value (BLRV) [ATSDR 2021]	0.049 µg/dL
Dust‡	10 µg/ft^2— Interior Floors 40 µg/ft^2— Porch Floors 100 µg/ft^2— Interior Windowsill 100 µg/ft^2— Window Trough	HUD 2017 Clearance Action Levels [HUD 2017]	< 10 µg/ft^2
Residential Yard Soil§	400 ppm	EPA site-specific remedial action level [EPA 2004a, 2010]	9 ppm
Municipal and Private Well Drinking Water	15 µg/L	EPA's Action Level [EPA 2004b, 2008]	Private Well Water: 1.00 µg/L Municipal Water: 5 µg/L
Paint¶	1 mg/cm^2	HUD 2012 Guidelines [HUD 2012]	< 1mg/cm^2

*µg— microgram; dL— deciliter; ft^2— square foot; L— liter; ppm— parts per million; mg/cm^2— milligram per square centimeter; CDC— Centers for Disease Control and Prevention; EPA— U.S. Environmental Protection Agency; HUD— U.S. Department of Housing and Urban Development; <— Less than

†CDC's BLRV is for screening blood lead levels in children and is not intended for screening adult populations.

‡ MDL is 10 µg/wipe based on a recommended sample area of 2 square feet.

§ EPA currently recommends a regional screening level for composite samples of 200 parts per million (ppm) or 100 ppm if an additional source of lead exposure is identified (e.g., lead water service lines, lead-based paint, non-attainment areas where the air lead concentrations exceed National Ambient Air Quality Standards [NAAQS]) [EPA 2024]. Based on the historic contamination at this site, ATSDR screened lead in soil with EPA's previously established site-specific remedial action level of 400 ppm.

¶ The MDL for measuring lead in paint can fluctuate with each sample based on the duration of the measurement, the sample matrix, and the presence of interfering or highly elevated contamination levels.

Table 2. Summary of the Number of Households Sampled and Exceeding Screening Levels*†

Sampled Media	Number (N) of Households Sampled	Number (%) of Households Exceeding Screening Levels
Soil	42	11 (26.2%)
Outdoor paint†	26	4 (15.4%)
Municipal Water	26	0 (0.0%)
Indoor paint†	25	3 (12.0%)
Dust	25	6 (24.0%)
Private Well Water	2	0 (0.0%)

* One household did not allow inside access and only outdoor paint was measured. All three homes with elevated lead in indoor paint also had elevated lead in outdoor paint.

†There were 59 households where blood was sampled in at least one individual. The number of households exceeding the BLRV has been omitted to protect confidentiality.

5.3 Evaluation of Blood Lead

Screening Analysis

ATSDR sampled BLLs in 59 households with women of child-bearing-age (age 15–44) and/or eligible children (age 0–5). Across all 59 households, three children had BLL results that were at or above the recommended BLRV of 3.5 µg/dL. Potential factors related to the measured BLLs above CDC's BLRV are discused in Section 5.9.

The specific number of children and women of child-bearing age that were sampled during this EI can be seen in Table 3 below. See Appendix F (Table F1) for a full breakdown of BLLs measured in both eligible and non eligible participants. Ineligible participants included siblings of eligible participants aged 6–14 and some residents that were determined to live outside of the recruitment area after the blood draw.

Table 3. Age Stratified Blood Lead Sample Numbers and Results *†

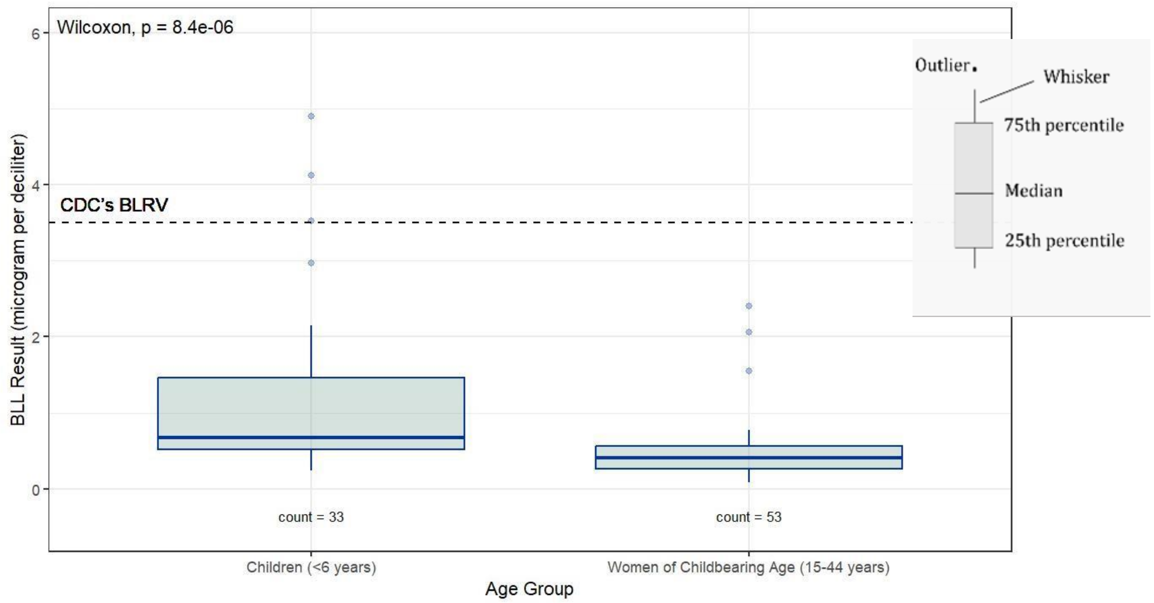
Age of participant	Number of Participants Sampled	Number of Valid Blood Lead Samples	Number (%) of Participants with Blood Lead Levels Above CDC's BLRV (3.5 micrograms per deciliter)
Children, 0–5 years	41	33	3 (9.09%)
Females, 15–44 years	70	53	0 (0.00%)
Total Eligible Results	**111**	**86**	**3 (3.49%)**

*CDC— U.S. Centers for Disease Control and Prevention; BLRV— Blood Lead Reference Value

†For some participants, the blood sample clotted and was not able to be analyzed by the laboratory (Invalid Sample). Every person whose blood clotted was offered a retest, and one adult participant (Females, 15–44) came back for a retest.

Blood was sampled from 111 individuals. Due to issues with blood clotting, only 86 samples (77%) could be analyzed. Participants whose sample could not be analyzed due to clotting were offered the opportunity to give another sample, and all but 1 participant declined. Figure 3 shows the distribution of BLLs for children and women of childbearing age. BLLs were statistically higher in children than women of child-bearing age.

Figure 3. Boxplot of Blood Lead Levels Measured in Jasper and Newton Counties*†



*BLL— Blood lead level; CDC— U.S. Centers for Disease Control and Prevention; BLRV— Blood Lead Reference Value; CDC's BLRV is 3.5 micrograms of lead per deciliter; p— probability that the two data sets are not different

†Boxplot notes: Whiskers extend to the largest or lowest value within 1.5 times the interquartile range. The Interquartile range is defined as the difference between the 75th and 25th percentile of the data.

Evaluation of Blood Lead Levels

Three of 33 (9.1%) children under 6 years of age with valid blood samples had BLLs above the CDC's BLRV (3.53, 4.12, and 4.90 µg/dL). The BLRV represents the highest 2.5% of BLLs of children 1–5 years old in the U.S. population. For direct comparison of the age groups, there were 28 EI participants betweeen 1–5 years old resulting in 10.7% exceeding the BLRV. Although a higher percentage of the EI participants from 1–5 years of age exceeded the BLRV than the U.S. population, this percentage was a result of 3 children with BLLs above CDC's BLRV. ATSDR compared the data from Jasper and Newton Counties to NHANES data at both the 50th and 95th percentiles (See Table 4). At the 50th percentile the two data sets were not statistically different (P-value is greater than 0.05), and thus, on average, BLLs measured in Jasper and Newton Counties are similar to levels measured across the U.S. At the 97.5th percentile, the two data sets are statistically different (P-value is less than 0.05), and a higher percentage of children 1–5 years old sampled in this EI had BLLs above CDC's BLRV than in the general population.

Table 4. Jasper and Newton Counties' Blood Lead Level (BLL) Results Compared to the National Health and Nutrition Examination Survey (NHANES)

Children (ages 1–5)	50th Percentile (µg/dL) p = 0.2858	97.5th Percentile (µg/dL) p = 0.03213
Jasper/Newton	0.87	4.38
NHANES BLL	0.66	3.5

*BLL— Blood lead level; NHANES— National Health and Nutrition Examination Survey; µg/dL— micrograms of lead per deciliter; p— probability that the two data sets are not different

5.4 Evaluation of Household Water

Screening Analysis

Overall, water was sampled in 28 housholds. Twenty-six of the homes use municipal water and two of the homes use private well water. Lead was not detected in any of the water samples.

Evaluation of Exposure to Lead in Household Water

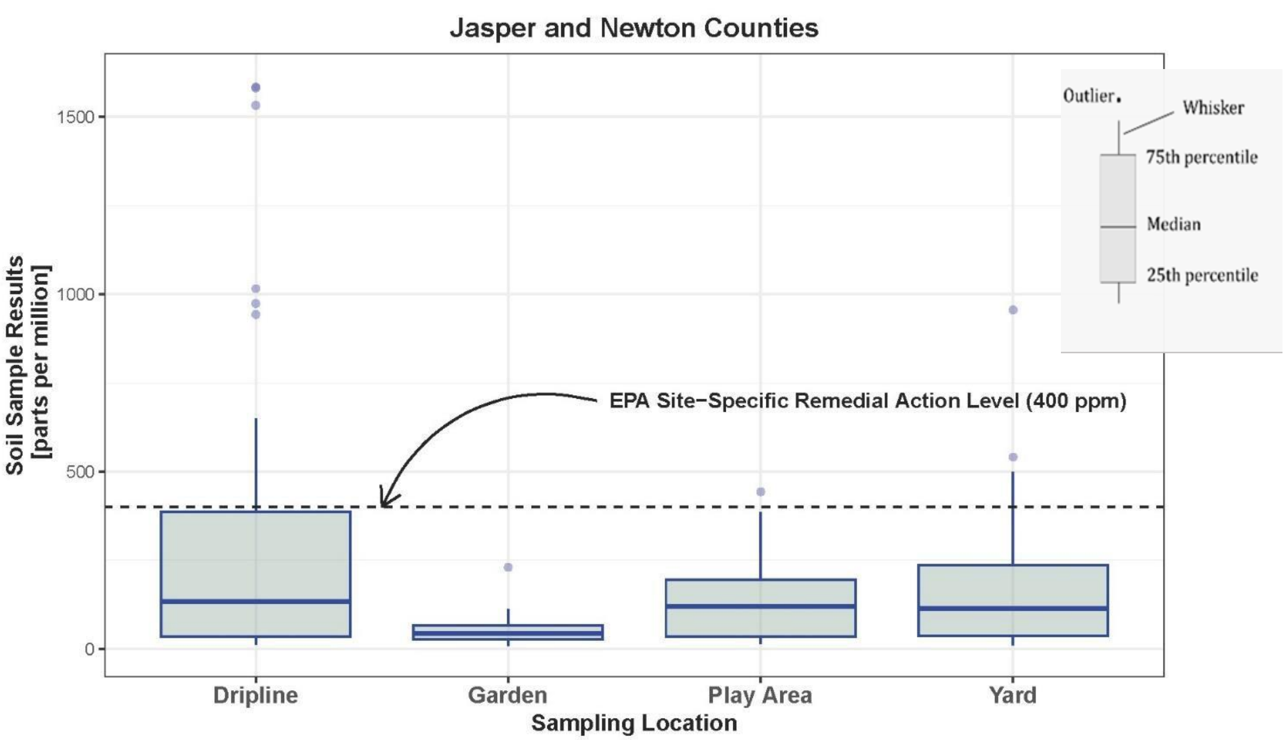
Since lead was not detected in private water wells or municipal water samples, adverse health effects are unlikely from exposure to lead via ingestion of water. However, due to inability to gain access to homes and/or owner consent, water was not sampled from all homes where BLLs were measured, which limits the evaluation of the relationship between BLLs and lead in water.

5.5 Evaluation of Lead in Residential Yard Soil

Screening Analysis

Eleven of 42 households (26%) had soil samples that exceeded the the EPA site specific remedial action level for lead in soil (400 ppm). For each household, soil samples were collected in four locations as available: yard, dripline, garden, and play area. Figure 4 shows the boxplots of the measured concentrations of lead in soil at each location.

Figure 4. Boxplot of Lead Levels in Soil Measured in Jasper and Newton Counties*



*Boxplot notes: Whiskers extend to the largest or lowest value within 1.5 times the interquartile range. The Interquartile range is defined as the difference between the 75th and 25th percentile of the data.

Evaluation of Exposure to Lead in Soil

The highest concentrations of lead were measured in the dripline areas around the home. Of the 11 households that exceeded the EPA site specific remedial action level, 2 had elevated lead in other

samples (i.e., in paint and dust). Due to inability to gain access to homes and/or owner consent, soil was not sampled from all homes where BLLs were measured, which limits the evaluation of the relationship between BLLs and lead in soil.

The measured data from this EI show a statistically significant positive correlation between the average child BLLs in each household and the lead soil concentration from the yard (p-value = 0.0254), dripline (p-value = 0.0144), and play area (p-value 0.0478). No significant associations were found between BLLs and the lead soil concentration of the garden (p-value = 0.613).

See Appendix F, Table F2 for other indicators of lead measured in homes with elevated lead in soil; Table F3 for the number of soil samples and the concentrations measured in each county; and Figure F1 for correlation graphs for each soil sampling location.

5.6 Evaluation of Lead in Dust

Screening Analysis

Twenty-five homes were sampled for lead in dust using surface wipes. Six of those homes had at least one dust sample that exceeded the HUD clearance action level. None of the participants in the 6 homes had BLLs above CDC's BLRV. In the homes exceeding the HUD clearance action level, lead was measured in the dust on the kitchen floor and on windowsills of the child's bedroom, the kitchen, and the living room.

Evaluation of Exposure to Lead in Dust

Although some of the homes had elevated levels of lead in dust, none of the EI participants living in those homes had BLLs above CDC's BLRV. Due to inability to gain access to homes and/or owner consent, dust was not sampled in all homes where BLLs were measured, which limits the evaluation of the relationship between BLLs and lead in dust. Dust samples were not collected at the home of any of the children with BLLs above CDC's BLRV. There was no correlation between the measured BLLs and the lead measured in floor dust or windowsill dust. Of the 6 households with elevated lead in dust, 5 had other indicators of lead exposure such as elevated lead in other samples (i.e., in paint or soil). See Appendix F, Table F2 for other indicators of lead measured in homes with elevated lead in dust and Table F4 for concentrations of lead in dust measured at different locations within the home.

5.7 Evaluation of Lead in Paint

Screening Analysis

Four of 26 households (15%) had at least one paint sample test positive for lead using XRF technology. Three of the 4 households tested positive for lead in indoor and outdoor paint. All households with elevated lead in paint had other indicators of lead exposure such as elevated lead in other samples (i.e., in soil or dust). See Appendix F, Table F2 for other indicators of lead measured in homes with elevated lead in paint and Table F5 for concentrations of lead in paint measured at different locations around the home.

Evaluation of Exposure to Lead in Paint

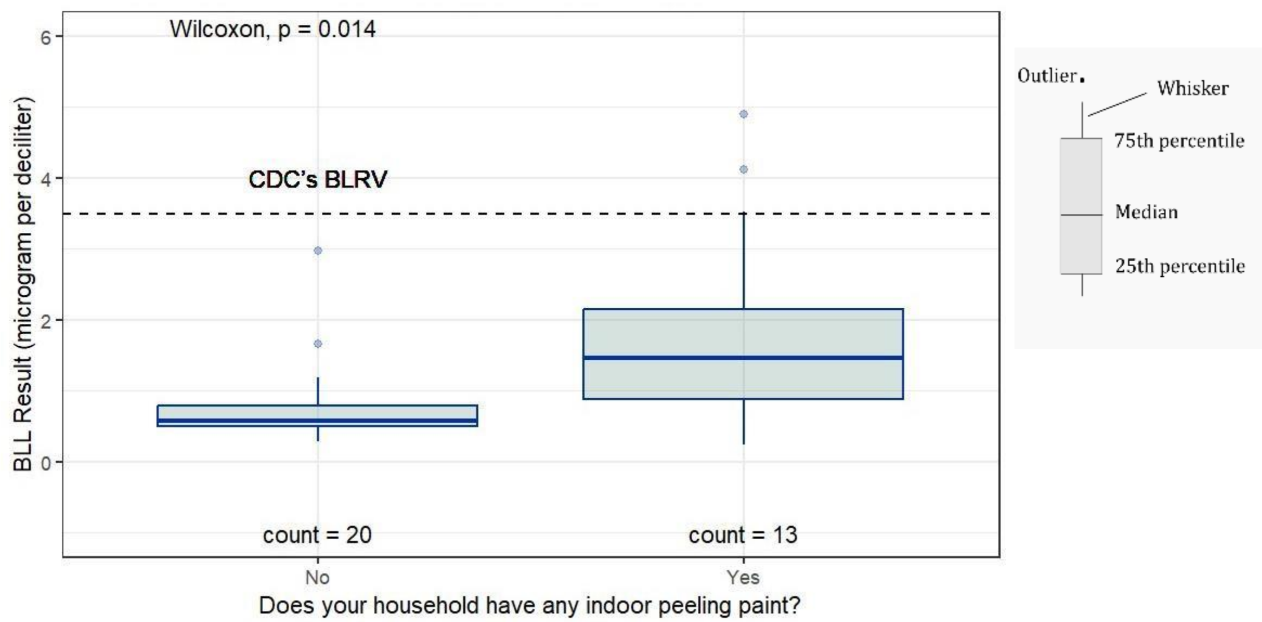
Although some of the homes had lead paint, none of the EI participants living in those homes had BLLs above CDC's BLRV. There was no correlation between the measured BLLs and the concentration of lead measured in indoor or outdoor paint. Due to inability to gain access to some homes and/or owner

consent, paint was not sampled in all homes where BLLs were measured, which limits the evaluation of the relationship between BLLs and lead in paint.

5.8 Evaluation of the Questionnaire Compared to Blood Lead Levels

ATSDR evaluated the data collected from questionnaires administered to EI participants to determine factors that may be associated with BLLs above CDC's BLRV in the community. Only three children had BLLs above CDC's BLRV, and each reported the use of home remedies, a house in less than good condition, and peeling indoor paint. From the data collected from the questionnaire, the self-reported use of home remedies, presence of chipping interior paint, and a house in less than good condition were the only factors associated with BLLs above CDC's BLRV. The significance in these questions is largely driven by the positive answers from the 3 children with BLLs above CDC's BLRV. Figures 5 and 6 show the boxplots for the blood lead distribution based on answers to peeling interior paint and condition of the home respectively.

Figure 5. Distribution of Blood Lead Levels and the Self-reported Presence of Indoor Peeling Paint*†‡

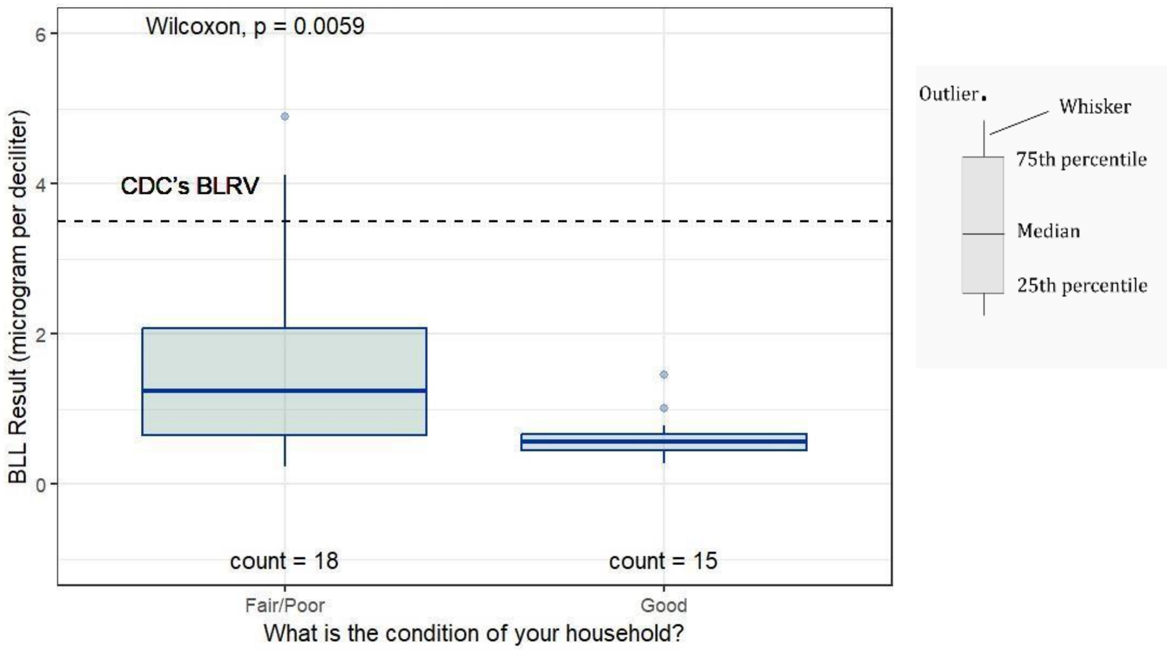


*BLL— Blood Lead Level; p— probability that the two data sets are not different; CDC— U.S Centers for Disease Control and Prevention; BLRV— Blood Lead Reference Value; CDC's BLRV is 3.5 micrograms of lead per deciliter

†The significance in these questions is largely driven by the BLLs above CDC's BLRV measured in three children.

‡Boxplot notes: Whiskers extend to the largest or lowest value within 1.5 times the interquartile range. The Interquartile range is defined as the difference between the 75th and 25th percentile of the data.

Figure 6. Distribution of Blood Lead Levels and the Self-reported Condition of the Home*†‡



*BLL— Blood Lead Level; p— probability that the two data sets are not different; CDC— U.S Centers for Disease Control and Prevention; BLRV— Blood Lead Reference Value; CDC's BLRV is 3.5 micrograms of lead per deciliter

†The significance in these questions is largely driven by the BLLs above CDC's BLRV measured in three children.

‡Boxplot notes: Whiskers extend to the largest or lowest value within 1.5 times the interquartile range. The Interquartile range is defined as the difference between the 75th and 25th percentile of the data.

5.9 Potential Factors Related to BLLs above CDC's BLRV

Three EI participants (children 1–5 years old) had BLLs above CDC's BLRV. These three participants also had the highest lead concentrations in soil. Dust, paint, and water samples were not collected from the three participants with BLLs above the CDC's BLRV. From the questionnaires, the BLLs in the three children may be related to the following:

- Use of home remedies in the month prior to blood sampling,
- Reports of home having indoor peeling paint, and
- Reports of condition of home as "fair/poor" (on a scale of good, fair, and poor).

5.10 Addressing Community Concerns

Lead Exposures in Jasper and Newton Counties

Other than the BLLs above CDC's BLRV measured in 3 children, BLLs measured in Jasper and Newton Counties were similar to levels measured in a representative sample of children aged 1-5 of the U.S. general population.

Actions for Participants with BLLs above CDC's BLRV

ATSDR attempted to contact the parent/guardian of each participant with BLLs above CDC's BLRV to help them identify ways to reduce the child's/ward's exposure to lead but attempts to contact via phone and home visit were not successful.

Historic Soil Screening Levels and the New BLRV

Although EPA's RSL for lead in soil was reduced to 200 ppm in 2024, thousands of homes in Jasper and Newton Counties have been screened and/or remediated using previous guidance. ATSDR compared soil concentrations to EPA's site-specific remedial action level of 400 ppm. All participants with soil concentrations below the previous EPA screening levels for lead had BLLs below the BLRV. Although it appears that historic soil remediation strategies in Jasper and Newton Counties were effective in reducing exposure to lead, the results of the EI are not intended to determine the efficacy of the remediation levels. Reduction in lead exposure in the community is likely related to a variety of measures taken to reduce environmental exposures to lead (e.g., health education) and cannot be attributed to the remediation of residential soil alone.

5.11 Summary of Limitations and Uncertainties

- The specific source of a participant's exposure may be unknown.
- Participants' blood lead concentrations cannot be used to predict the future occurrence of disease nor be attributed as the cause of current or past health problems. Though the health effects associated with lead exposure are well documented, there are numerous factors that can contribute to the development of disease.
- Measurements of lead in soil, dust, and paint represent a single point in time; environmental conditions such as seasonality, weathering, and other exposure variables may change the nature of lead contamination over time.
- Answers to the questionnaire were self-reported by participants and are subject to reporting bias.
- The number of participants recruited may not give ATSDR a complete understanding of the extent of exposure attributable to historic lead mining, milling, and smelting in the areas of Jasper and Newton Counties.
- ATSDR and the study partners were not able to collect environmental samples at every household with blood lead data, which limits the determination of the source of lead and the correlation of environmental samples to BLLs.
- Blood samples for 25 of 111 participants (23%) clotted and were not able to be analyzed by the laboratory. Every person whose blood clotted was offered a retest, but only one adult participant was retested. In all, blood samples for 8 children and 17 women of childbearing age could not be analyzed.
- The results of this EI will be applicable only to the individuals tested in these specific communities and cannot be generalized to the community nor to other populations.
- The results of the EI cannot be used to evaluate the efficacy of remedial levels in either Jasper or Newton Counties to reduce lead exposure.

6. Conclusions

Conclusion 1: A higher percentage of children 1–5 years old sampled in this EI had BLLs above CDC's BLRV; however, this increase is driven by three children with BLLs above CDC's BLRV. The average, BLLS measured near the ODMB and NCMT sites are similar to the average levels measured in a representative sample of children aged 1-5 of the U.S. general population.

Basis for conclusion: ATSDR compared the measured BLLs of residents in Jasper and Newton Counties to NHANES data for children 1–5 years old. Of the 28 participants between the ages of 1–5 years old with

valid blood lead data, 3 (10.7%) had BLLs above CDC's BLRV (3.53, 4.12, and 4.90 µg/dL). This percentage is significantly higher than the 2.5% of BLLs above CDC's BLRV from the NHANES data. At the 50th percentile, the BLLs measured in Jasper and Newton Counties were not significantly different than that of NHANES.

Conclusion 2: Higher blood lead levels measured in Jasper and Newton Counties are associated with contaminated residential soil, the self-reported condition of the home, and the use of home remedies.

Basis for conclusion: BLLs measured during this EI were positively correlated to measured lead concentrations in the soil in the yard, soil in the play area, and soil along the drip line of the home. Some responses to the questionnaire provided to community participants were also positively correlated with BLLs, including the condition of the home being less than good, the presence of chipping or peeling paint, and the use of home remedies. The significance of these findings is largely driven by BLLs above CDC's BLRV measured in 3 children. All 3 children had additional indicators of lead exposure (i.e., high levels of lead in residential soil samples, self-reported condition of the home being less than good, peeling and/or chipping interior paint, and use of home remedies).

Conclusion 3: Historic soil remediation strategies used in conjunction with other methods to reduce exposure in Jasper and Newton Counties, such as health education, may be effective in reducing exposure to lead to the current standards.

Basis for conclusion: No BLLs above CDC's BLRV were observed in homes that were below EPA's 1998 site-specific remedial action level for lead in residential yard soil. Individuals with BLLs above CDC's BLRV had the highest lead soil concentrations measured in this EI, with samples exceeding current and historic screening levels. Although it appears that soil remediation strategies along with health education and other efforts in the area are effective in reducing exposure to lead in Jasper and Newton Counties, the results of the EI are not intended to determine the efficacy of the remediation levels and do not apply to the general public.

7. Recommendations and Public Health Action Plan

- Local public health agencies (LPHAs), in cooperation with MDHSS through cooperative agreements with ATSDR and the EPA, should continue health education activities to reduce environmental exposure to lead in the community.
- MDHSS and LPHAs should continue to promote and offer access to blood lead testing for children and women of childbearing age in the area.
- EPA should continue to promote and offer access to lead-soil sampling for residential yards in the area and remediate residential yards with elevated lead in soil.
- EPA and MDHSS should continue to promote and offer access to lead dust and paint sampling for homes of children in the area with BLLs above CDC's BLRV.
- EPA, MDHSS, and LPHAs should continue to promote and offer access to private well testing, and Missouri Department of Natural Resources should continue to promote municipal water testing for lead and other associated heavy metal contaminants for homes in the area.

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Appendix A: Brief Summary of ATSDR's Public Health Assessment (PHA) Process

The Agency for Toxic Substances and Disease Registry (ATSDR) follows the Public Health Assessment (PHA) process to evaluate whether people living near a hazardous waste site are being exposed to toxic substances, whether that exposure is harmful, and what must be done to stop or reduce exposure.

The PHA process is a step-by-step approach during which ATSDR does the following:

- establishes communication mechanisms, including engaging communities at the beginning of site activities and involves them throughout the process to respond to their health concerns;
- collects many different kinds of site information;
- obtains, compiles, and evaluates the usability and quality of environmental and biological sampling data (and sometimes modeling data) to examine environmental contamination at a site;
- conducts four main, sequential scientific evaluations;

  Exposure pathways evaluation— ATSDR identifies past, present, and future site-specific exposure situations, and categorize them as completed, potential, or eliminated.

  Screening analysis— ATSDR compares the available sampling data to media-specific environmental screening levels (ATSDR comparison values and non-ATSDR screening levels). This identifies potential contaminants of concern that require further evaluation for completed and potential exposure pathways.

  Exposure Point Concentrations (EPCs) and exposure calculations— When contaminants are flagged as requiring further evaluation in completed and potential exposure pathways, ATSDR calculates EPCs based on site-specific scenarios. The estimated EPCs are used in exposure calculations to determine if any of the site-specific exposure scenarios require an in-depth toxicological effects analysis.

  In-depth toxicological effects evaluation— If necessary, based on the three previous scientific evaluations, ATSDR looks more closely at contaminant-specific information in the context of site exposures. This evaluation can also help determine if there is a potential for non-cancer or cancer health effects.

- summarizes findings and next steps, while acknowledging uncertainties and limitations.
- provides recommendations to site-related entities, partner agencies, and communities to prevent and minimize harmful exposures.

The sequence of steps can differ based on site-specific factors. For instance, health assessors might define an exposure unit before or after the screening analysis.

Readers can refer to ATSDR's Public Health Assessment Guidance Manual for all information related to the steps of the PHA process.

Appendix B. Description of Assessments and Conclusions, and Timeline of Efforts to Reduce Exposure to Lead in Jasper and Newton County

Description of Notable Published Documents Related to Lead in Jasper and Newton County

ATSDR Preliminary Health Assessment for Oronogo-Duenweg Mining Belt, Jasper County Missouri [ATSDR 1990]— ATSDR concluded that the site is of public health concern due to probable exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to heavy metals may be occurring and may have occurred in the past via ingestion of contaminated groundwater, soil, sediment, and inhalation of soil and sediment particles suspended in air. Levels of lead and cadmium exceeding the EPA proposed Maximum Contaminant Level (MCL) were documented in the few wells sampled. Other environmental pathways for which there are no data may represent additional exposure routes.

MDOH Exposure Study in Jasper County [MDOH 1994]— The Missouri Department of Health (MDOH) conducted the Jasper County, Missouri Superfund Site Lead and Cadmium Exposure Study. The study, beginning in 1991 and released in May 1994, concluded that 14% of children under the age of seven years in the study area had elevated blood-lead concentrations (greater than 10 micrograms per deciliter). Additionally, the study concluded that the most significant source of contamination resulting in elevated blood-lead levels was residential yard soils.

EPA Time Critical Removal Action for Jasper County Missouri [EPA 1995a]— The Time-Critical Removal Action included residences where children were observed with high blood-lead concentrations (above 15 micrograms per deciliter (µg/dl) lead in the blood) or where soil lead levels exceeded 2,500 parts per million (ppm) (the level which the health agencies believe may cause blood lead levels [BLLs] to exceed 15 µg/dl), and day-care centers with soil lead levels above 500 ppm. The clean-up activities consisted of excavating and removing soils, replacing the soil with clean backfill, and revegetating the yards. The EPA performed cleanup at approximately 303 residential yards and seven-day care centers under this action, which concluded in March 1996. The majority of daycares and homes identified for cleanup were around the Eagle-Picher smelter in Joplin.

ATSDR Final Report for Jasper County, Missouri Superfund Site Lead and Cadmium Exposure Study [ATSDR 1995]— This study evaluated 391 exposed persons and 271 individuals from an area where no mining has occurred. Results of the study found that BLLs were significantly higher in children in the exposed group compared to the control group. Fourteen percent of the study children had BLLs ≥ 10 µg/dl, which was the level set by the Centers for Disease Control and Prevention (CDC) at that time indicating intervention was required. None of the children in the control area had elevated levels.

There was no significant difference for cadmium between the two groups. Also, the study determined environmental exposure to the area soil was the most important factor influencing the distribution of BLLs between the two groups.

EPA Area-Wide Human Health Risk Assessment for the Jasper County Superfund Site, Jasper County, MO [EPA 1995b]— This assessment was prepared by MDOH using EPA's Integrated Exposure Uptake/Biokinetic Model (IEUBK, version 0.99d). Two exposure scenarios were evaluated using the IEUBK: a child living on designated area/transition zone soils, and a child living on mine/mill waste.

Demographic survey data was used as model inputs wherever possible. The model predicted that for children living on designated area/transition zone soils, the average blood lead concentration would be 5.9 µg/dL with 12% of the children exceeding CDC's level of concern at that time of 10 µg/dL. The model predicted that the average blood lead concentration of children living on mine/mill waste would be 7.4 µg/dL, with 25% of the children exceeding CDC's level of concern of 10 µg/dL. Ingestion of local produce accounted for most of the total lead uptake.

EPA Record of Decision (ROD) for Residential Yard and Mine Waste Yard Soils, Operable Units 02 and 03 Oronogo-Duenweg Mining Belt Site, Jasper County Missouri [EPA 1996]— The Superfund Site was divided into 4 operable units (OU): OU1 consisted of nonresidential soil contamination that poses a risk to the environment, OU2 is residential yard waste in smelter areas; OU3 is residential yard waste in areas of mining and milling; and OU4 consists of contaminated private water wells. In order to clean up the contamination which poses the greatest health threat first, the decision was made to initially focus on OU2 and OU3 which included residential yards and daycare centers. Residences contaminated solely by sources other than historic mining (e.g., lead paint) were included in this effort with health education and phosphate stabilization. The major components of ROD were as follows:

- Excavation and replacement of residential yard soils
- Construction of a repository for excavated soil
- Sampling of additional residential yards in mining and smelter areas
- Establishing institutional controls for residential and day care center development
- Continuation of the ongoing health education program
- Conducting a phosphate stabilization treatability study
- Phosphate stabilization of yard soils if treatability study results are positive

EPA Superfund Record of Decision for Jasper County OU4 Contaminated Wells [EPA 1998]— In 1993, EPA began distributing bottled water to residents accessing contaminated shallow groundwater. By the time of this document [EPA1998], all residents were either accessing public water systems or given bottled water. This report determined that the deep groundwater aquifer, which is the source for the public water, was safe for consumption. Dermal exposure to metals via showering was negligible. The ROD included continued provisions of public water through construction of public water distribution systems; providing point of use treatment systems to homes in remote areas that cannot be connected to public water supplies; continuation of the bottled water provisions until the needed infrastructure is constructed (estimated completion date 1–2 years); and institutional controls and monitoring.

ATSDR Final Report for Jasper County, Missouri Superfund Site Childhood 2000 Lead Exposure Study [ATSDR 2002]— By June 2000, the EPA had remediated 2,288 residential yards (to a level below 500 ppm) and implemented major intervention efforts, including an aggressive community education campaign. Only two percent of the children tested that were living in the same area as selected for the 1991 study had BLLs greater than or equal to 10 µg/dL. This is an 86% reduction in the number of children suffering from lead poisoning. BLLs declined on average by 2.42 µg/dL between 1991 and 2000 (mean BLLs for the 2000 study were 3.82 ± 2.29 µg/dL). The results indicated that educational and environmental interventions were effective in reducing the mean BLLs of children residing in the area close to the levels of the control group in the 1995 study. Although it is not possible to determine the individual contribution of the soil remediation compared to the health education and paint stabilization, it is reasonable to conclude that the substantial soil remediation actions contributed significantly to the

reduction in numbers of children with elevated BLLs. Since those children with the higher mean lead levels were those with multi-media exposure, it is important to combine lead paint remedial actions with soil remediation.

EPA Record of Decision for Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Mine and Mill Waste, Operable Unit 01 [EPA 2004]— This operable unit addresses mine and mill waste contamination at non-residential properties that present an ecological risk to plants and wildlife and a potential human health risk if the land is developed for residential use. In addition to the soil remediation strategies, EPA supports an institutional control that is implemented by the county that requires the builders of residential homes to test and remediate non-residential properties prior to constructing residential homes. An occupancy permit will only be granted by the county if soil lead concentrations are below 400 ppm and cadmium is below 75 ppm. Builders will be required to properly cleanup soils exceeding these levels prior to receiving the occupancy permit.

ATSDR Public Health assessment of Newton County Mine Tailings [ATSDR 2006]— The Newton County site was classified as a public health hazard for past, present, and future exposure based on the following conclusions:

- Lead and cadmium contamination present in the ground water at levels above current health-based drinking water limits.
- Some residential yards in all the subdistricts and Spring City area were found to have lead levels above site-specific removal action limits.
- High levels of contaminants are present at the source areas that have yet to be remediated; therefore, exposure may occur to remediation workers, trespassers, and others that may occupy or work around the source areas. Exposure could also occur if the area is developed or used for other purposes before it is completely remediated.

EPA Record of Decision for Newton County Mine Tailings Superfund Site, Newton County, Missouri, Mine Waste Remediation, Operable Units 1 and 2 [EPA 2010]— This Superfund site was separated into 4 OUs: OU1— Mine and Mill waste in Diamond/Spring City-Spurgeon/Granby (PRP activities); OU2— mine and mill waste in the remainder of Newton County (EPA activities); OU3— Spring River Watershed OU4— groundwater.

There are presently no residential soil cleanup levels documented in a ROD for Newton County Mine Tailings, and an ROD amendment was not released prior to the completion of this health consultation in 2024.

EPA August 2022 Fifth 5-year review of Oronogo-Duenweg Mining Belt, Jasper County, Missouri and EPA November 2019 First 5-year review of Newton County Mine Tailings [EPA 2022]— In the latest five-year review, EPA recognized that the site-specific action and cleanup levels for residential soil may not be protective considering the current EPA policy and guidance related to remediation of lead-contaminated residential yards. Their recommendation was to review available residential yard data and address the protectiveness of historic action and cleanup levels.

Timeline of Efforts to Reduce Exposure to Lead in Jasper County

June 1990— ATSDR Preliminary Health Assessment for Oronogo-Duenweg Mining Belt identifies lead as a hazard [ATSDR 1990].

1993— EPA began distributing bottled water to residents accessing contaminated shallow groundwater through their private drinking water well [EPA 1995a].

May 1994— MDOH Exposure Study in Jasper County concluded that 14% of children under the age of seven years in the study area had elevated blood-lead concentrations (Greater than 10 µg/dl). Soil was identified as the most significant source [MDOH 1994].

January 1995— EPA expedited remediation at residences where children were observed with high blood-lead concentrations (above 15 µg/dl) or where soil lead levels exceeded 2,500 ppm (the level which the health agencies believe may cause blood-lead levels to exceed 15 µg/dl), and day-care centers with soil lead levels above 500 ppm [EPA 1995b].

February 1995— ATSDR Jasper County exposure study determines BLLs were significantly higher in children in the exposed group compared to the control group. Lead in soil was the most important factor [EPA 1995b].

October 1995— EPA assessment uses models to predict between 12 and 25% of children living on and around mine waste will exceed CDC's level of concern at that time of 10 µg/dL. Ingestion of local produce was a significant source for lead uptake [EPA 1995b].

June 1996— EPA ROD for OU2 and OU3 documented the cleanup levels for residential soils, including daycares and high child use areas. Specifically, an action level of 800 ppm for lead in residential soil and a cleanup level of 500 ppm for lead in residential yard soil was established [EPA 1996].

September 1998— The EPA ROD for OU4 Contaminated Wells established action levels for private domestic drinking water wells and included continued construction of public water distribution systems; providing point of use treatment systems to homes in remote areas; bottled water provisions; and institutional controls and monitoring [EPA 1998].

July 2002— ATSDR Final Report on the Childhood 2000 Lead Exposure Study in Jasper County found that only two percent of the children tested that were living in the same area as selected for the 1991 study had BLLs greater than or equal to 10 µg/dl. This is an 86% reduction in the number of children suffering from lead poisoning. BLLs declined on average by 2.42 µg/dL between 1991 and 2000 [ATSDR 2002].

September 2004— The EPA signed a Record of Decision (ROD) for the cleanup of the remaining mine wastes at the Site under OU1. This includes remedy components for addressing source material, contaminated soil and sediment. EPA selected a remedial action level for lead of 400 ppm [EPA 2004].

2008— EPA entered into a Cooperative Agreement with the Jasper County Health Department and Missouri Department of Health and Senior Services to implement Jasper County's Environmental Contamination Ordinance and to enact lead health education measures [EPA 2010].

2013 and 2016— The 2004 OU1 ROD was amended to increase volume and expand the scope of the 2004 remedy [EPA 2022].

Timeline of Efforts to Reduce Exposure to Lead in Newton County

1986— Preliminary EPA assessment in Granby area showed elevated levels of lead, cadmium, and zinc in soil and groundwater [ATSDR 2006].

1989— MDNR confirmed elevated levels in soil and surface water [ATSDR 2006].

1995— EPA conducted an expanded site assessment around Granby, Wentworth, and Stark City. Spring City was added to the assessment based on a child with an elevated blood lead level, and eventually the assessment was expanded to mining areas throughout the county [ATSDR 2006].

1998— Due to large numbers of residences with contaminated drinking water, EPA begins providing bottled water to residents [ATSDR 2006, EPA 2010].

1999— Responsible Parties (Under Administrative Order on Consent) and EPA began remediation of residential yards. The performance standard was total lead at 400 ppm or 75 ppm total cadmium [ATSDR 2006, EPA 2010].

2003— Newton County added to NPL list. EPA begins construction of public water supplies. One-hundred individual deep-aquifer drinking water wells were installed for homes where it was not feasible to install public water supply mains [EPA 2010].

June 2010— The EPA signed a ROD that addresses the cleanup of the mine waste, contaminated soil, and intermittent stream sediments generally in non-residential areas that present an ecological risk to plants and wildlife and a potential human health risk if the land is developed for residential use [EPA 2010].

2018 and 2020— EPA increased the estimated volume of remaining mine waste, contaminated soil, and intermittent stream sediments generally in non-residential areas described in the 2010 ROD [EPA 2019].

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[MDOH] Missouri Department of Health. 1994. Jasper County Missouri Superfund Site Blood-Lead and Urine-Cadmium Exposure Study. Summary. May 1994.

Appendix C. Historic Screening Levels for Lead in Blood and Soil and Blood Lead Levels in Children in Jasper and Newton Counties

Historically, screening levels for lead in blood have been based on the highest 2.5–5% of the population, and not on health effects observed at the screening value. As exposure to lead in the environment has been reduced over time, so have the average BLLs in the U.S. population and thus the blood lead screening levels. CDC now recommends a BLRV of 3.5 µg/dL. This level is based on the 97.5th percentile of the blood lead values among U.S. children ages 1–5 years from the 2015–2016 and 2017–2018 National Health and Nutrition Examination Survey (NHANES) cycles. Children with BLLs at or above the BLRV represent the top 2.5% of blood lead levels (BLLs) in the most susceptible population [ATSDR 2021].

As the blood lead screening levels have been lowered over time, the recommended concentration of lead in soil has also decreased. Guidance for lead in soil is based on EPA's Integrated Exposure Uptake Biokinetic Model for lead in children (IEUBK). The IEUBK predicts BLLs in young children (birth to 7 years of age) exposed to lead from several sources of exposure and routes. Tables C1 and C2 below show the historic screening level for lead in blood and soil respectively.

Table C1. Historic Screening Levels for Lead in Blood

Recommended Blood Lead Screening level µg/dL
10 µg/dL— From 1991 to 2012, children were identified as having a blood lead value at a "level of concern" if the test result was 10 micrograms per deciliter (µg/dL) or more of lead in blood. CDC is no longer using this term and is instead using the blood lead reference value to identify children who have more lead in their blood than most children [Dignam 2019].
5 µg/dL— In 2012, the Centers for Disease Control and Prevention (CDC) introduced a blood lead "reference value" to identify children with higher levels of lead in their blood compared to most children. This level is based on the 97.5th percentile of the blood lead values among U.S. children ages 1–5 years from the 2007–2008 and 2009–2010 NHANES cycles [CDC 2012]. Children with BLLs at or above the BLRV represent those at the top 2.5% with the highest BLLs.
3.5 µg/dL — In 2021 the BLRV was updated based on the 97.5th percentile of the blood lead values among U.S. children ages 1–5 years from the 2015–2016 and 2017–2018 NHANES cycles. Children with BLLs at or above the BLRV represent those at the top 2.5% with the highest BLLs [ATSDR 2021].

µg/dL— microgram per deciliter; NHANES— National Health and Nutrition Examination Survey; IEUBK— Integrated Exposure Uptake Biokinetic Model

Table C2. Historic Screening Levels for Lead in Soil

Recommended Soil-lead screening level
800 ppm— Since 1994, EPA has recommended the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) as a risk assessment tool to support environmental cleanup decisions at current and future anticipated residential sites. This value was used to screen discrete soil samples collected in individual residential yards. The highest recorded sample was used to trigger a cleanup action for the yard [EPA 1994].
400 ppm— Guidance was updated in 1998 based on the current version of the IEUBK model (IEUBKv2), using 10 µg/dL as the 95th percentile target blood lead level and national default lead concentrations. This value was used to screen composite samples collected in specific areas of individual residential yards The highest composite (average) sample was used to trigger a cleanup action for the yard [EPA 1998].
200–100 ppm— Updated in 2024, EPA currently recommends a regional screening level for composite samples of 200 parts per million (ppm) or 100 ppm if an additional source of lead exposure is identified (e.g., lead water service lines, lead-based paint, non-attainment areas where the air lead concentrations exceed National Ambient Air Quality Standards [NAAQS]) [EPA 2024]. The current version of the model (IEUBKv2), using 5 µg/dL as the 95th percentile target blood lead level and national default lead concentrations, predicts a soil lead concentration of approximately 200 ppm and a geometric mean blood lead level is 2.3 µg/dL [EPA 2024]. EPA has not evaluated the IEUBKv2 below 5 µg/dL (upper percentile of the blood lead distribution) [EPA 2024].

ppm— parts per million; IEUBK— Integrated Exposure Uptake Biokinetic Model; NAAQS— National Ambient Air Quality Standards [NAAQS]

Figures C1 and C2 below represent the incidence of elevated BLLs in children in Jasper and Newton Counties compared to the state of Missouri from the years 2004 to 2022. The data are based on the number tested and the population, respectively. The data below, prepared by Missouri Department of Health and Senior Services' Environmental Public Health Tracking program, includes both capillary and intravenous samples [MDHHS 2023].

Figure C1. Incidence of Childhood Elevated Blood Lead Levels per Number Tested

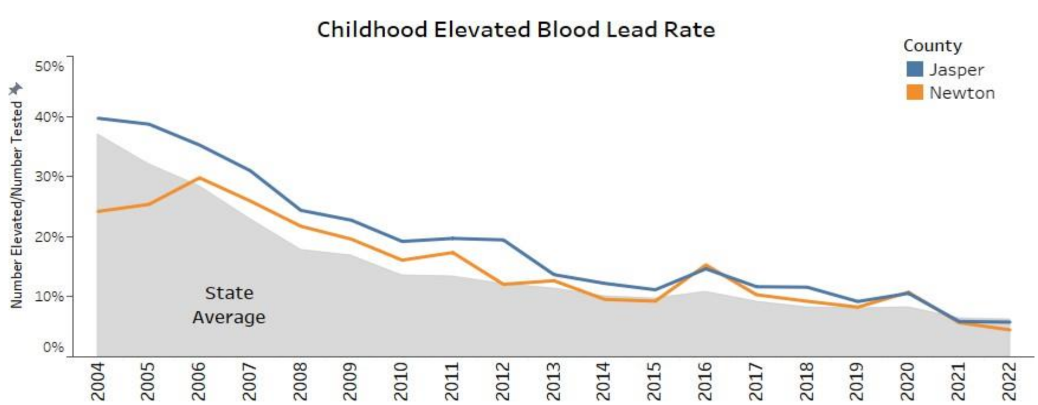
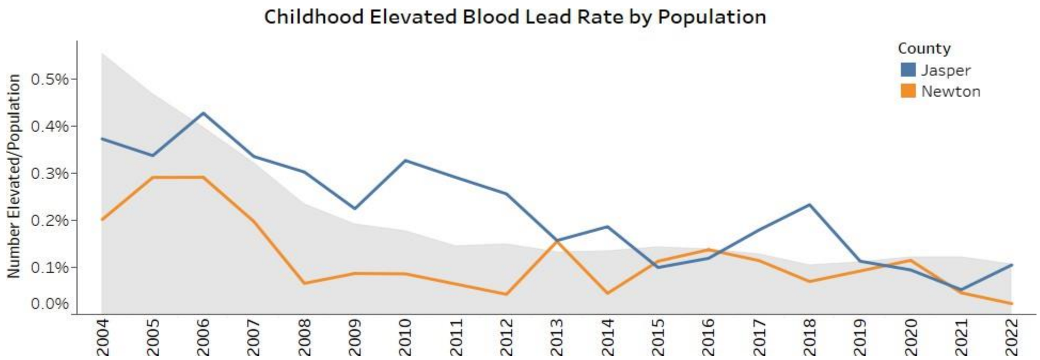


Figure C2. Incidence of Childhood Elevated Blood Lead Levels per Population



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https://healthapps.dhss.mo.gov/MoPhims/MOPHIMSHome

Appendix D: Sampling Protocols

Blood Sample Collection

Blood collection events were conducted at central locations in Jasper and Newton Counties. In Jasper County, blood was collected at the Joplin Library August 16–20, 2022. For Newton County, blood was collected at the Newton County YMCA August 12–15, 2022. Blood collection included the following:

1. At the time of blood collection eligible participants completed the following:
   - a consent/parental permission form and questionnaire for ATSDR,
   - a property access form for EPA, and
   - a property access form for MDHSS.
2. A venous blood sample was obtained from each participant and submitted to NCEH/DLS for analysis.
3. MDHSS was scheduled to collect samples of municipal water and dust (surface wipes) and evaluate paint samples inside and outside the home using an XRF monitor. MDHSS provided participants using municipal drinking water with a sample container and instructions for sample collection. Residents used the instructions to collect a sample on the day MDHSS sampled their indoor/outdoor environment to ensure a first-draw sample.
4. EPA was scheduled to collect samples of soil and private well water.
5. ATSDR provided EPA and MDHSS with the addresses for participants where environmental samples were to be collected.

Blood sample collection and analysis were done according to the Center for Disease Control and Prevention's Division of Laboratory Services (DLS) method 3040.1-04916.8-02 (https://wwwn.cdc.gov/nchs/data/nhanes/2019-2020/labmethods/PBCD-K-PBY-K-R-MET-508.pdf).

Blood was collected by a certified phlebotomist using appropriate blood drawing protocols. A phlebotomist collected approximately 3 milliliters (mL) of blood from a vein of each participant who provided consent using 3mL ethylenediamine tetra-acetic acid coated pre-screened evacuated tubes provided by the DLS laboratory.

The blood samples were maintained at an appropriate refrigerator temperature (2–8° C) after collection and shipped on ice packs by overnight delivery to DLS. DLS analyzed blood samples for lead concentration in whole blood by inductively coupled plasma mass spectrometry. EI personnel adhered to the Health and Safety Plan provided when handling and shipping blood samples.

XRF Sampling for Environmental Assessment

SOP 100

Evaluation of Indoor and Outdoor Paint Using an XRF

ATSDR Exposure Investigation

Jasper and Newton Counties, MO

1. **Purpose:** The purpose of this Standard Operating Procedure (SOP) is to establish uniform procedures for the collection of information for the completion of the indoor environmental assessment and XRF sampling to determine the presence of lead-based paint.

2. **Application:** The procedures outlined in this SOP are applicable to all personnel collecting environmental samples for the Oronogo-Duenweg Mining Belt and Newton County Mine Tailings ATSDR Lead Exposure Investigation in Jasper and Newton Counties, MO.

3. **General Guidelines:** Direct reading XRF measurements will be made on selected interior and exterior surfaces that are painted or varnished. The condition of the painted surfaces will be recorded. The sample collection process is based on the U.S. Department of Housing and Urban Development (HUD) guidelines. A worst-case scenario evaluation will determine sample locations within each room. Areas that have the most potential to be a hazard (i.e., deteriorated paint) will be sampled.

4. **Selection of Sample Locations:** The Home Schematic Form (FORM 100) will be completed.
   - 4.1. XRF measurements will be obtained by taking one reading from each unique test combination of the child's bedroom, kitchen, child's main play area, two exterior walls, and porch.
   - 4.2. Components to be sampled include window components, door components, walls, cabinets, and floors that are painted or coated.

5. **Sampling Equipment:** Sampling equipment will at minimum consist of:
   - 5.1. Portable XRF unit
   - 5.2. Non-alcohol wipes
   - 5.3. XRF calibration source(s)

6. **Method of Sampling:**
   - 6.1. Complete FORM 100
     - 6.1.1. Place pre-prepared ID sticker on top left corner and add date.
     - 6.1.2. Include a room plan sketch on the back of FORM 110 used for each room.
       - 6.1.2.1. All schematic diagrams will be labeled using the convention of Main address exterior wall labeled 'A' with sequential lettering (B, C, and D) in a clockwise

direction. The room number will be '1' for the child's bedroom, '2' for the kitchen, and '3' for the child's main play area. On the sketch clearly indicate the direction for North.

6.1.3. Complete the general information questions for the home.

6.1.3.1. Inspector and location type information.

6.1.3.2. Exterior covering type and water source. (See key at bottom of FORM 100).

6.1.4. Complete information for each room to be sampled.

6.1.4.1. Floor is the floor of the house. The front entry floor area is floor '1'. If there is a basement of lower floor then it is indicated as '0'.

6.1.4.2. Indicate floor type from the key at the bottom of the data collection FORM 100.

6.1.4.3. If not wall-to-wall carpet, indicate if piece carpet is present. A 'N' circled indicates no piece carpet present.

6.1.4.4. If the child's bedroom or kitchen is also the child's main play area then indicate here as 'Y'. If not indicate 'N'.

6.1.4.5. Indicate the general condition of neatness of the room on a rating scale (See key at bottom of FORM 100).

6.2. XRF measurements are obtained in interior rooms, two exterior walls, and one exterior porch (this should be the MAIN PORCH). One sample is taken from each unique test combination. A test combination is determined by component type and substrate material.

6.2.1.1. **Interior** sampling within each of the child's bedroom, kitchen, and child's main play area (FORM 110).

6.2.1.1.1. One reading representative of the most accessible interior window area. Take the reading on the sash.

6.2.1.1.2. One reading representative of the most accessible outer window area. Take the reading on the sill/stool (where the child has access).

6.2.1.1.3. One reading representative of the most accessible interior door. **Note:** If no door is present, this sample is not taken.

6.2.1.1.4. One reading representative of the most accessible door jamb.

6.2.1.1.5. One representative floor reading, unless carpeted.

6.2.1.1.6. One reading of the most accessible wall.

6.2.1.1.7. One reading of the most accessible baseboard, if present.

6.2.1.1.8. One reading of the most accessible radiator, if present.

6.2.1.1.9. One representative reading of cabinets and/or shelves.

6.2.1.2. **Exterior** sampling (FORM 120).

6.2.1.2.1. Readings are taken from only two exterior walls. The first wall will be the side with the MAIN PORCH, or if no porch then WALL A. The second wall is at the discretion of the Risk Assessor. If there is an obvious difference among the walls, the second wall should be selected to represent this.

6.2.1.2.1.1. From each of the two walls, take one reading representative of each test combination of: wall, window sash, window trough (if available), door, and door jamb.

6.2.1.2.2. Main porch. Only one exterior porch is tested. If more than one porch is present, the Risk Assessor must decide which porch is most representative in usage.

6.2.1.2.2.1. One reading representative of each porch component: floor, banister, column. If doors and windows are present, they should be included as part of 'wall' form.

6.3. Obtaining XRF Measurements.

6.3.1. Perform XRF calibration check prior to use, at the end of each sampling day or every four hours, and if the instrument is knocked, dropped, or other impact, turned off for more than two hours, or has been exposed to extreme temperature changes for more than an hour. Using the 1.02 mg/cm^2 source (or other as recommended by the PCS). Take three consecutive measurements. If any single measurement is off by more than 0.4 mg/cm^2, or the average of each of the three measurements is off by more than 0.2 mg/cm^2, then turn the instrument off, then on again, and repeat. If this occurs again, contact the manufacturer concerning how to correct this.

6.3.2. If surface is visibly soiled or dusty, wipe surface with a non-alcohol wipe as necessary and/or place a piece of plastic or paper (such a tissue) between the instrument and surface. Use a clean piece of paper or plastic that has previously been checked for possible interference. This is to ensure that the XRF window is not contaminated, and sample results are from the paint and not surface deposited material. If this surface will be used for a wipe sample, perform the wipe sample first (See SOP 200).

6.3.3. On FORM 110 for each area tested enter all the following information on a new form:

6.3.3.1. Place pre-prepared ID sticker and add date.

6.3.3.2. Indicate inspector and XRF instrument.

6.3.3.3. For indoor samples indicate room number (1 – child's bedroom, 2 – kitchen, 3 – child's main play area).

6.3.3.4. Indicate number of doors and windows in sample area for rooms and walls.

6.3.3.5. For each XRF sample taken for the specific components indicated on the form:

6.3.3.5.1. If condition intact or deteriorated:

6.3.3.5.1.1. Intact indicates no obvious visible deterioration.

6.3.3.5.1.2. Deteriorated includes any paint coating on a damaged or deteriorated surface or fixture, or any interior or exterior lead-based paint that is peeling, chipping, blistering, flaking, worn, chalking, alligatoring, cracking, or otherwise becoming separated from the substrate.

6.3.3.5.2. Estimated percent of total damage area represented by this sample.

6.3.3.5.3. XRF result (mg/cm^2) reported by instrument.

6.3.4. On FORM 120 for the two exterior/outdoor walls tested enter all the following information.

- 6.3.4.1. Place pre-prepared sticker and add date.
- 6.3.4.2. Indicate inspector and XRF instrument.
- 6.3.4.3. Indicate location letters for Wall 1 and Wall 2. Wall 1 should either contain the MAIN PORCH and/or be Wall A.
- 6.3.4.4. Indicate number of doors and windows. This is the combined number for the two walls selected and includes those within a porch area.
- 6.3.4.5. For each XRF reading taken for the specific components indicated on the form:
  - 6.3.4.5.1. If condition intact or deteriorating:
    - 6.3.4.5.1.1. Intact indicates no obvious visible deterioration.
    - 6.3.4.5.1.2. Deteriorated includes any paint coating on a damaged or deteriorated surface or fixture, or any interior or exterior lead-based paint that is peeling, chipping, blistering, flaking, worn, chalking, alligatoring, cracking, or otherwise becoming separated from the substrate.
  - 6.3.4.5.2. Estimated percent of total damage area represented by this sample.
  - 6.3.4.5.3. XRF result (mg/cm^2) reported by instrument.

6.3.5. On FORM 120 for the MAIN PORCH enter all the following information.

- 6.3.5.1. Place pre-prepared ID sticker and add date.
- 6.3.5.2. Indicate inspector and XRF instrument.
- 6.3.5.3. Indicate wall letter the MAIN PORCH is located.
- 6.3.5.4. For each XRF sample taken for the specific components indicated on the form:
  - 6.3.5.4.1. If condition intact or deteriorating:
    - 6.3.5.4.1.1. Intact indicates no obvious visible deterioration.
    - 6.3.5.4.1.2. Deteriorated includes any paint coating on a damaged or deteriorated surface or fixture, or any interior or exterior lead-based paint that is peeling, chipping, blistering, flaking, worn, chalking, alligatoring, cracking, or otherwise becoming separated from the substrate.
  - 6.3.5.4.2. Estimated percent of total damage area represented by this sample.
  - 6.3.5.4.3. XRF result (mg/cm^2) reported by instrument.

Dust Wipe Sampling

SOP 200
Collection of Dust using a Surface Wipe Sample
ATSDR Exposure Investigation
Jasper and Newton Counties, MO

1. **Purpose:** The purpose of this SOP is to establish uniform procedures for the collection of interior dust wipe samples.

2. **Application:** The procedures outlined in this SOP are applicable to all personnel collecting environmental samples for the Oronogo-Duenweg Mining Belt and Newton County Mine Tailings ATSDR Blood Exposure Investigation in Jasper and Newton Counties, MO.

3. **General Guidelines:** Samples will be collected from each location type. Wipe sample site selection will be performed after FORM 100 is complete. The sample collection process is based on the U.S. Department of Housing and Urban Development (HUD) guidelines. A worst-case scenario evaluation will determine sample locations within each room. Areas that have the most potential to be a hazard (i.e., near deteriorated paint or lead-paint hazards) will be sampled.

4. **Selection of Sample Locations:** Wipe samples will be obtained from the entryway, primary living area, kitchen, child's bedroom, and child's main play area. Nine samples plus one blank will be collected per household.
   - 4.1. Entryway: A sample will be collected from just inside the entryway on the floor.
   - 4.2. Primary living area: Two samples will be collected, one from the floor and one from the windowsill.
   - 4.3. Kitchen: Two samples will be collected, one from the floor and one from the windowsill.
   - 4.4. Child's bedroom: Two samples will be collected, one from the floor and one from the windowsill.
   - 4.5. Interior play area: Two samples will be collected, one from the floor and one from the windowsill.

5. **Sampling Equipment:** Sampling equipment will consist of a minimum of:
   - 5.1. Disposable gloves
   - 5.2. Individual wrapped sampling wipes
   - 5.3. Measuring tape
   - 5.4. Masking or painter's tape
   - 5.5. Moistened towelettes or baby wipes
   - 5.6. Sample tubes
   - 5.7. Reusable floor template (optional)

6. **Method of Sampling:**
   - 6.1. Place pre-prepared ID sticker and add date (FORM 200).
   - 6.2. Prepare sample collection tube with complete sample number and date. The sample number consists of the ID# and assigned sample number (e.g., D-E-1 for an entryway sample, D-L-F-1 for a primary living area floor sample, etc.). Sample numbers for each type are indicated on FORM 200.
   - 6.3. Record all information on FORM 200.
     - 6.3.1. Dimensions of the area wiped should be recorded to the closest quarter inch. For a floor use a clean sampling template or tape to mark out a 12” x 24” sample area. For a windowsill tape a rectangular area adjacent to the window sash, this area should not include edges along the side of the vertical window casing, and should be at least 4” x 4”, larger if possible.
     - 6.3.2. If surface being wiped is deteriorated, such as chipping and flaking paint, delaminating, and so on, indicate the condition (Y/N) on FORM 200.
     - 6.3.3. If loose soil/dust is seen in the sample, indicate (Y/N) on FORM 200.
     - 6.3.4. If paint chips are seen in the sample, indicate (Y/N) on FORM 200.
     - 6.3.5. Only comments concerning conditions or sampling procedure that would affect interpretations of results should be recorded.
   - 6.4. Put on new disposable gloves for each sample.
   - 6.5. When a reusable floor template is used, wipe clean between samples and tape to the floor to keep it from moving while wiping.
   - 6.6. To sample floors, remove a sampling wipe from package, carefully unwrap, do not touch other objects.
     - 6.6.1. Place wipe down firmly at an upper corner of the sample area, excessive pressure will cause the wipe to curl, and too little pressure will result in poor collection. Make as many “S”-like motions as needed to wipe the entire sample area moving side-to-side. Do not cross the outer border of the template or tape.
     - 6.6.2. Fold the wipe in half with the contaminated side facing inward, take care not to spill dust when folding. Once folded, place the wipe in the upper corner of the sample area and repeat wiping with “S”-like motions to wipe the entire sampling area, this time moving from top-to-bottom. Do not cross the outer border of the template or tape. Fold the wipe in half again with the dust collection side facing inward and make a third pass around the perimeter of the sample area, concentrating on any remaining dust in the corners of the wiping area. If visible dust remains use a second wipe to collect the remaining dust and clearly note on the form the need to composite the wipes for analysis.
     - 6.6.3. Place the wipe(s) into the labeled collection tube.
   - 6.7. To sample windowsills, remove a sampling wipe from package, carefully unwrap, do not touch other objects.

- 6.7.1. If the surface is a narrow rectangle, two side-to-side passes must be made over the sample area, the second pass should be made with the wipe folded so that the contaminated side faces inward.
  - 6.7.1.1. Do not attempt to wipe the irregular edges presented by the contour of the window trough or the rounded inside edge of the sill.
- 6.7.2. If there are paint chips or debris in the sample area of the trough, it should be collected as part of the dust sample.
- 6.7.3. Fold the wipe with the contaminated side facing inward again.
- 6.7.4. Place the wipe into the labeled collection tube.

6.8. Continue until all wipes of each type have been collected, all waste should be collected and disposed of off-site.

6.9. Field sample blanks

- 6.9.1. A field sample blank for each home is required by the State Public Health Laboratory (SPHL).
- 6.9.2. Before leaving the dwelling, remove a wipe from the package with a new glove, shake the wipe open, refold it in a manner like the above procedures, and place into a labeled collection tube, clearly labeled “blank”.

7. **Sample Analysis**: Samples were analyzed by a state public health laboratory using inductively coupled plasma optical emission spectrometry.

Soil Sampling

SOP 300
Collection of Residential Yard Soil Samples
ATSDR Exposure Investigation
Jasper and Newton Counties, MO

1. **Purpose:** The purpose of the SOP is to establish uniform procedures for the collection of soil samples.

2. **Application:** The procedure outlined in this SOP is applicable to all personnel collecting environmental samples for the Oronogo-Duenweg Mining Belt and Newton County Mine Tailings ATSDR Lead Exposure Investigation in Jasper and Newton Counties, MO. Samples were only collected on properties where the owner, tenant, or occupant consented to access.

3. **General Guidelines:** A rough sketch of the aerial view of the yard will be made which includes the division and indication of the yard areas into sample site categories for: dripline, yard non-play area, and play area/s. A composite soil sample will be collected from each category. Disposable gloves will be worn for the collection of all samples.

4. **Selection of Sample Locations:**
   - 4.1. Soil sampling will include a composite collected from the general yard non-play area within approximately 100 feet of the structure, dripline within three feet of structure walls, and primary play areas of the child. As sampling proceeded, additional areas (such as garden) were added as necessary following the same sampling strategy as other areas of the yard described below.
   - 4.2. An aerial view diagram of the residence and property will be sketched on the reverse side of the Soil Collection Form (FORM 300). The dripline will include the areas contiguous with and extending three feet from the house walls. The general yard non-play area will extend from the drip line to the yard outer boundaries not to exceed 100 feet or a distance that is reasonably considered to include areas where a child may frequent. Play areas will extend three feet beyond a play area boundary or play equipment.
   - 4.3. Dripline
     - 4.3.1. The drip-line soil composite sampling sites (9) will be located 1 ½ feet away from the wall and any water discharge locations (i.e., see diagram for approximate locations). Adjustments may be made based on field conditions.
   - 4.4. General Yard Non-Play Area
     - 4.4.1. Sampling sites for the yard will be determined by superimposing a "+" using the mid-point of the structure as the center. Sample sites (9) will be taken from each of the four quadrants and combined into one composite (36) sample. Adjustments may be made based on field conditions.

4.5. High Contact/Play Area

4.5.1. Play area samples (9) will be taken in a similar manner as the general yard non-play area. Up to two primary play or high contact areas (i.e., gardens) will be sampled.

5. **Sample Collection:**

5.1. Label sample storage container with pre-prepared ID sticker, sample number, and date. Sample numbers will be for general yard non-play area (Y-1), play area (P-1), garden area (G-1), and dripline (D-1). Sequential numbers may be used for additional samples of the same sample type (e.g., P-2).

5.2. Each sample location will be recorded using a global positioning system (GPS) unit. The GPS coordinates will be recorded in the field logbook.

5.3. Complete FORM 300 for composite sample to be obtained. This will entail:

5.3.1. Place pre-prepared ID sticker and indicate date. EPA may use additional stickers for laboratory use.

5.3.2. Determine the percent of bare ground (exposed soil) to covered ground in the region sampled. Covered ground is considered vegetation and hard surfaces (concrete, asphalt, etc.).

5.3.3. Following sample collection, indicate number of samples used for composite and note any adjustments made based on field conditions.

5.4. Use a new pair of disposable gloves for each composite type.

5.5. Insert collection instrument ½ to 1 inch into the soil and remove soil.

5.6. Remove any vegetation from top of soil sample and add to collection container.

5.7. Dispose of any remaining soil and wipe residual soil from sample probe.

5.8. Continue the process at each sample site placing each new composite into the sample container until all samples have been collected. Repeat for all composite types.

5.9. Unless dedicated equipment was utilized, de-contaminate sample probe by wiping off all visible soil with gloved hand and paper towels. Dispose of all waste off-site.

6. **Sample Analysis:**

6.1. Soil samples for each area will be homogenized in a clean, dedicated aluminum pan or plastic bag. Debris, such as sticks and larger stones, will be removed.

6.2. Each sample will be taken from the disposable pan or bag, dried, sieved by No. 100 (150 micrometers) sieve, homogenized, and packed into sample containers provided by the laboratory.

6.3. The soil samples will be analyzed using a combination of XRF screening and fixed-laboratory confirmation analyses.

6.4. Ten percent of the soil samples analyzed using ex-situ XRF will be sent as confirmation samples to the laboratory for lead analysis using inductively coupled plasma atomic emission spectrometry.

6.4.1. The confirmation samples will be selected from the lower, middle, and upper range of concentrations measured by the XRF [EPA, 2018].

6.5. The EPA Region 7 Generic Quality Assurance Project Plan (QAPP) for Region 7's Superfund Lead-Contaminated Sites and QAPP Addendum discuss EPA-specific sample documentation and handling.

7. **Laboratory Quality Control:**

7.1. Appropriate quality assurance/quality control (QA/QC) samples also will be prepared and collected including duplicate and matrix spike (MS)/matrix spike duplicate (MSD) samples.

7.1.1. Duplicate samples will be collected at a rate of 10 percent of the total number of soil samples.

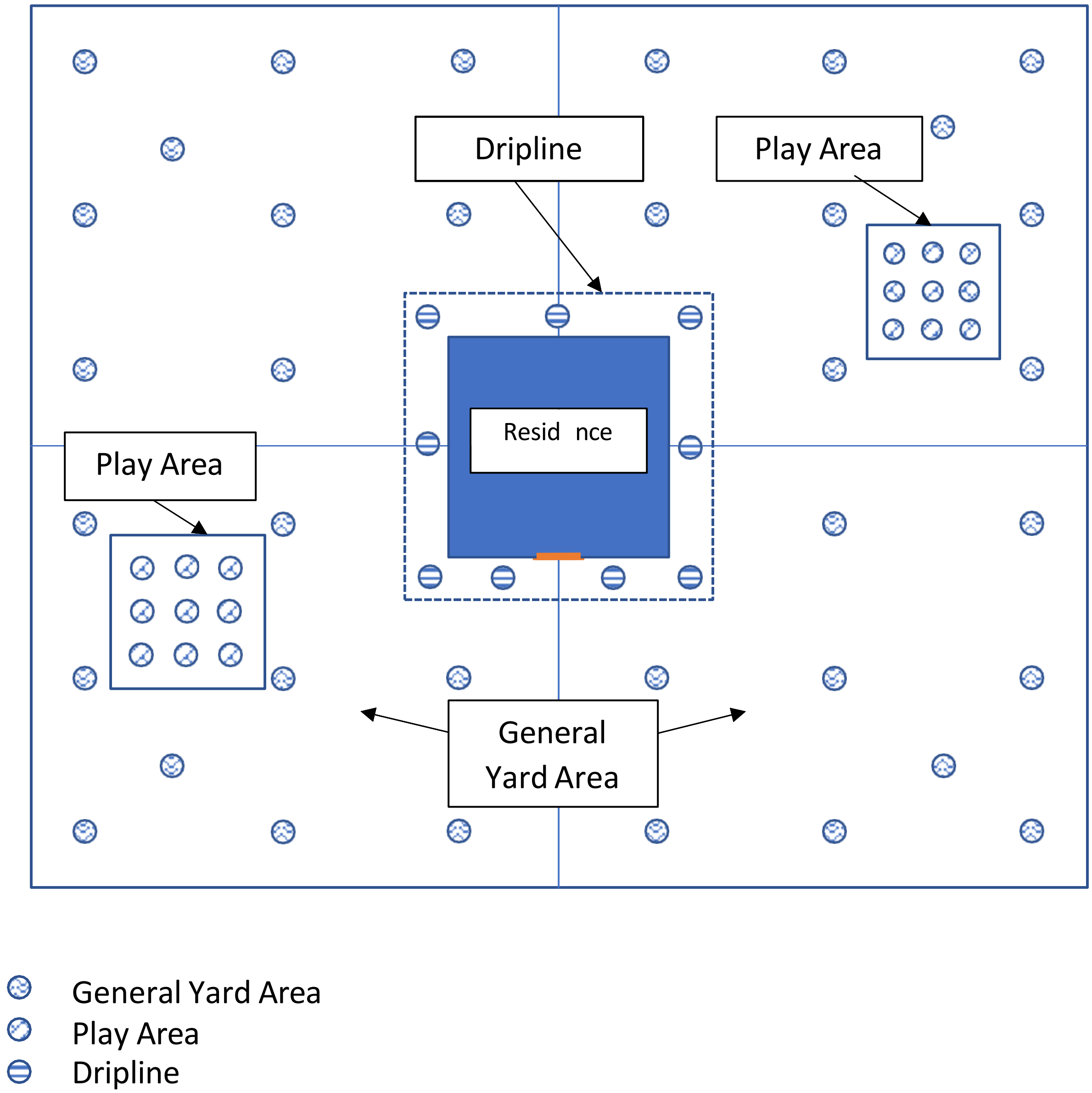
7.1.2. All QC samples will be uniquely identified and will be documented in EPA-specific field logbooks and field sheets.

7.1.3. All QC samples of the confirmation samples will be sent to the laboratory for analysis.

7.1.4. Precision for the fieldwork is evaluated by using the relative percent difference (RPD) between the results for the field duplicate samples.

7.1.4.1. An RPD goal of +/- 25% will be used for both field and lab analyses.

7.2. The EPA Region 7 Generic QAPP for Region 7's Superfund Lead-Contaminated Sites and QAPP Addendum discuss EPA-specific sample documentation and handling.



*This diagram provides an example of sample locations and should not be considered prescriptive. Adjustments to sample locations may be necessary depending upon field conditions, home layout, etc., however the number of samples collected per area (36 – general yard, 9 – play area, 9 – dripline) are required.

Private Well Drinking Water Sampling

SOP 400
Private Domestic Drinking Water Well Sample Collection
ATSDR Exposure Investigation
Jasper and Newton Counties, MO

1. **Purpose:** The purpose of this SOP is to establish uniform procedures for the collection of private drinking water samples.

2. **Application:** The procedure outlined in this SOP is applicable to all personnel collecting environmental samples for the Oronogo-Duenweg Mining Belt and Newton County Mine Tailings ATSDR Blood Lead Exposure Investigation in Jasper and Newton Counties, MO.

3. **General Guidelines:** Water samples are to be collected for participants on a private water supply (i.e., private well) from the kitchen faucet. At least 500 milliliters (mL) of water should be collected. Water samples for lead analysis are acidified upon receipt in the laboratory or upon sample collection with the use of pre-acidified containers.

4. **Sampling Equipment:** Sampling equipment will consist at minimum of:
   - 4.1. Disposable gloves
   - 4.2. One-quart laboratory supplied sampling containers
   - 4.3. Masking tape
   - 4.4. Large sealable plastic bag

5. **Method of Sampling:**
   - 5.1. Place pre-prepared ID sticker and add date on FORM 400.
   - 5.2. Label sample container with pre-prepared sticker and sample number W-1.
   - 5.3. Flush water line by letting the water run for at least 5 minutes before collecting sample.
   - 5.4. Place on fresh disposable gloves.
   - 5.5. Rinse container three times with water to be collected.
   - 5.6. Fill with at least 500 mL of water.
   - 5.7. Secure lid, tape with masking tape, and place into plastic bag.
   - 5.8. Please note if there is a water filtration system in the home.
   - 5.9. Affix any EPA-specific laboratory-provided sample sticker and package samples according to laboratory requirements.

6. **Sample Analysis**: Samples were analyzed by an EPA laboratory using inductively coupled plasma mass spectrometry.

Municipal Water Sampling

SOP 500

Municipal Water Sample Collection

ATSDR Exposure Investigation

Jasper and Newton Counties, MO

1. **Purpose:** The purpose of the SOP is to establish uniform procedures for the collection of municipal water samples.

2. **Application:** The procedure outlined in the SOP is applicable to participants collecting samples for the Oronogo-Duenweg Mining Belt and Newton County Mine Tailings ATSDR Blood Lead Exposure Investigation in Jasper and Newton Counties, MO.

3. **General Guidelines:** Water samples are to be collected by participants who are served by a public or rural water district. At least 250 mL will be collected to evaluate the potential for exposure to lead in pipes and/or kitchen tap fixtures.

4. **Sampling Equipment:**
   - 4.1. MDHSS supplied sampling container.
   - 4.2. Pen or permanent marker.

5. **Method of sampling:**
   - 5.1. Sample should be collected after water has been stagnant in pipes for an 8–18-hour period, this is typically first thing in the morning. Please collect this water sample as closely as possible to the day MDHSS will be sampling the paint and dust in your house.
   - 5.2. Fill the container immediately after turning on the faucet or opening the water valve with 250 mL of water.
   - 5.3. Secure the lid and mark the label with the date and time the sample was collected.
   - 5.4. Please note if there is a water filtration system in your home.
   - 5.5. MDHSS will pick up the sample the day they come to your home for dust and paint sampling.

6. **Sample Analysis**: Samples were analyzed by a state public health laboratory using inductively coupled plasma mass spectrometry.

Appendix E. Screening Levels (SLs) Used in the Jasper and Newton Counties Exposure Investigation

As part of the EI process, ATSDR compared the measured concentrations to appropriate screening levels (SLs) available from the Centers for Disease Control and Prevention (CDC) (blood lead), the U.S. Department of Housing and Urban Development (HUD) (paint samples collected using and XRF and dust samples collected using a surface wipe), and the U.S. Environmental Protection Agency (soil and water). A concentration above the SL does not necessarily mean that an adverse effect will occur, but it is an indication that the specific contaminant should be further investigated and compared to the health effects documented in scientific literature.

An individual's exposure to lead can only be determined by the direct measurement of the amount of lead in their blood. An individual's potential for exposure can be determined by the amount of lead in their environment. Each SL is described below.

The Center for Disease Control and Prevention Blood Lead Reference Value (BLRV)

No acceptable blood lead level (BLL) has been identified that is free from deleterious health effects in children from 1 to 5 years of age. CDC's blood lead reference value BLRV, 3.5 micrograms per deciliter (µg/dL), is a screening tool to identify children who have higher levels of lead in their blood compared with most children. The reference value is not health-based and is not a regulatory standard. This level is based on the 97.5th percentile of the blood lead values among U.S. children ages 1–5 years from the 2015–2016 and 2017–2018 National Health and Nutrition Examination Survey cycles. Children with BLLs at or above the BLRV represent those at the top 2.5% with the highest BLLs in the U.S.[ATSDR 2021]. To learn more about CDC's updated recommendations on children's BLLs, please visit: https://www.cdc.gov/lead-prevention/hcp/clinical-guidance/index.html.

HUD 2017 Clearance Action Levels for Lead in Household Dust

The U.S. Department of Housing and Urban Development's Office of Lead Hazard Control and Healthy Homes (OLHCHH) issues policy guidance to establish new and more protective requirements for dust-lead action levels for its Lead-Based Paint Hazard Control and Lead Hazard Reduction Demonstration Grantees. This policy guidance is used in conducting lead-based paint hazard risk assessments and for clearing units following interventions that disturb paint. This policy is supported by scientific evidence on the adverse effects of lead exposure at low blood-lead levels in children as well as the evidence that lower clearance levels are routinely achieved by lead hazard control programs. In 2017, the OLHCHH adopted the following new action levels for lead in dust [HUD 2017]:

- Less than 10 micrograms per square foot for interior floors,
- Less than 100 micrograms per square foot for windowsills,
- Less than 40 micrograms per square foot for porch floors, and
- Less than 100 micrograms per square foot for window troughs.

EPA's Regional Screening Levels for Lead in Soil and the Site-Specific Remedial Action Level for Jasper and Newton Counties

Regional screening levels (RSLs) are screening tools used to help identify and define areas that may need further evaluation. The RSL for lead in soil has decreased over time, and in January 2024, it was lowered from 400 parts per million to the current RSL of 200 ppm. EPA recommends a more health-protective RSL of 100 ppm if an additional source of lead is identified (e.g., lead water service lines, lead-based paint, non-attainment areas where the air lead concentrations exceed National Ambient Air Quality Standards [NAAQS]). The recommended RSL of 100 ppm considers aggregate lead exposure and increased risk to children living in communities with multiple sources of lead contamination [EPA 2024].

Due to the historic soil contamination and remedial efforts in Jasper and Newton Counties, ATSDR screened lead in soil using EPA's site-specific remedial action level for Jasper and Newton Counties (400 ppm). This site-specific value is more appropriate for screening in the area than the generic RSL.

Guidance for lead in soil is based on EPA's Integrated Exposure Uptake Biokinetic Model for lead in children (lEUBK). The IEUBK predicts BLLs in young children (birth to 7 years of age) exposed to lead from several sources of exposure and routes.

EPA Remedial Action Levels for Private Domestic Drinking Water Wells in Jasper and Newton Counties

In Jasper and Newton County, the drinking water action levels are set by Safe Drinking Water Act (SDWA). The SDWA was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources—rivers, lakes, reservoirs, springs, and ground water wells. SDWA does not regulate private wells which serve fewer than 25 individuals [EPA 2004]. SDWA authorizes the United States Environmental Protection Agency (US EPA) to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. The Lead and Copper Rule of the SDWA was established to protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity. This rule established an action level of 0.015 mg/L for lead and 1.3 mg/L for copper based on 90th percentile level of tap water samples [EPA 2008]. A drinking water action level exceedance can trigger other requirements that include water quality parameter monitoring, corrosion control treatment, source water monitoring/treatment, public education, and lead service line replacement. Although the action level for lead is intended for community water systems and non-transient non-community water systems, it was also used to screen private wells.

HUD 2012 Guidelines for Lead in Paint

The U.S. Department of Housing and Urban Development's Office of Lead Hazard Control and Healthy Homes (OLHCHH) regulates lead-based paint hazards in housing through the establishment of requirements for property owners and Federal agencies that mandate actions to improve the safety and effectiveness of lead-based paint activities. The OLHCHH defines a "Lead-Based Paint Hazard" as any paint containing 1 mg/cm^2 or more of lead regardless of its condition or location [HUD 2012].

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Appendix F. Additional Results Figures and Tables

Table F1. Blood Lead Results Stratified by Eligibility Status*

Age of participant	Number of Participants Sampled	Number of Blood Result Available	Number (%) of Participants with BLLs above CDC's BLRV (3.5 µg/dL)†
Eligible Children, 0–5 years	41	33	3 (9.09%)
Eligible Females, 15–44 years	70	53	0 (0.00%)
Total Eligible Results	**111**	**86**	**3 (3.49%)**
Ineligible Participants outside the sampling area	13	8	0 (0.00%)
Ineligible Children, 6–14 years	8	6	0 (0.00%)
Total Ineligible Results	**21**	**14**	**0 (0.00%)**
Grand Total (including eligible and ineligible participants)	**132**	**100**	**3 (3.00%)**

*As a public health service blood lead testing was performed on individuals not eligible for inclusion in the exposure investigation.

†CDC— U.S Centers for Disease Control and Prevention; BLRV— Blood Lead Reference Value; CDC's BLRV is 3.5; µg/dL— micrograms per deciliter

Table F2. Other Indicators of Lead Exposure in Homes with Elevated Soil Concentrations

Media	Number (percent) of households with elevated soil lead and indicators of lead in other media*†
Outdoor paint‡	2/11 (18.18)
Indoor paint‡	1/11 (9.09)
Dust	2/11 (18.18)
Questionnaire— Peeling Paint (Yes) §	6/11 (54.55)
Questionnaire— Household Condition (Fair or Poor) §	8/11 (72.73)
Questionnaire— Use of Home Remedies (Yes)	1/11 (9.09)

*Eleven households had elevated lead concentrations in soil when compared to EPA's site-specific remedial action level for Jasper and Newton Counties (400 parts per million).

†The number of households exceeding the BLRV has been omitted to protect confidentiality. Three participants with BLLs above the U.S Centers for Disease Control and Prevention blood lead reference value also reported the presence of indoor peeling paint, a home in fair condition, and had elevated lead in soil.

‡All homes with lead in indoor paint or outdoor paint also had lead in dust; All homes with lead in indoor paint also had lead in outdoor paint.

§Five households self-reported the presence of indoor peeling paint and a home in fair or poor condition.

Table F3. Soil Sample Results by Location and County*

Sampling Location	Number of Samples†	Minimum [ppm]	Maximum [ppm]	Number (%) above EPA's Site-Specific Remedial Action Level‡
Jasper & Newton Dripline	42	13	1,652	11 (26.19%)
Jasper & Newton Garden	10	<4.5	230	0 (0.00%)
Jasper & Newton Play Area	25§	14	443	1 (4.00%)
Jasper & Newton Yard	42	11	956	4 (9.52%)

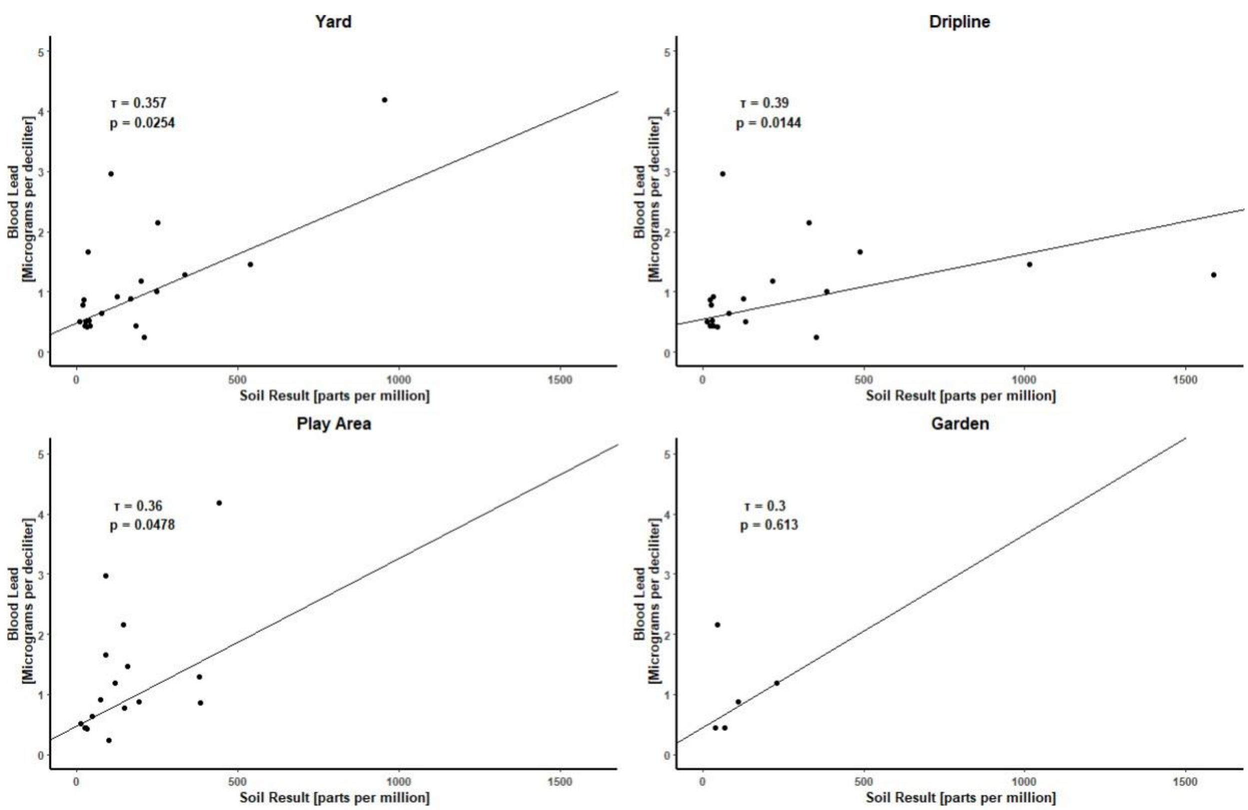
*ppm— parts per million; % — percent of samples; EPA— U.S. Environmental Protection Agency; <— less than

†Composite samples were collected at each location resulting in one sample per household accept where noted.

‡EPA's site-specific remedial action level for Jasper and Newton Counties is 400 ppm.

§One household had two play areas sampled.

Figure F1. The Correlation Between Mean Blood Lead Levels in Each Household and Lead Levels in Soil for Jasper and Newton Counties*



t=Kendall's Tau, p=probability.Note: Lines on the graphs indicate Akritas-Theil-Sen nonparamateric line

*The Tau value (τ) and probability (p) show a statistically significant, positive correlation between blood lead levels and soil lead concentrations measured in the yard dripline and play area outside the home.

Table F4. Lead in Dust Results Summary*

Sample Location	Number of Samples	Number Above HUD's CAL	Minimum Concentration ($\mu g/ft^2$)	Maximum Concentration ($\mu g/ft^2$)
Entryway Floor	21	0	<10	7
Adult's Bedroom Floor	1	0	<10	<10
Adult's Bedroom Windowsill	2	0	<10	<10
Child's Bedroom Floor	24	0	<10	<10
Child's Bedroom Windowsill	24	4	<10	1740
Child's Play Area	4	0	<10	<10
Kitchen Floor	25	1	<10	12
Kitchen Windowsill	22	2	<10	246
Primary Living Area Floor	22	0	<10	10
Primary Living Area Windowsill	22	2	<10	126

*HUD— U.S. Department of Housing and Urban Development; CAL— clearance action level; $\mu g/ft^2$— micrograms per square foot

Table F5. Indoor and Outdoor Paint (XRF) Results *

Sample Location	Number of Samples	Number Above HUD Screening Level†	Minimum Concentration (mg/cm^2)	Maximum Concentration (mg/cm^2)
Indoor Cabinets/Shelves	44	0	0	0.11
Indoor Door Area	136	2	0	13.60
Indoor Floor	144	0	0	0.60
Indoor Window Area	147	2	0	14.30
Indoor Wall	77	0	0	0.40
Indoor Other‡	8	1	0	2.60
Outdoor Door Area	69	2	0	17.50
Outdoor Porch	55	2	0	27.10
Outdoor Walls	51	5	0	31.50
Outdoor Window Area	76	5	0	31.70

*XRF— X-Ray Fluorescence (XRF); HUD— U.S. Department of Housing and Urban Development; mg/cm^2— milligram per square centimeter

†HUD defines a "Lead-Based Paint Hazard" as any paint containing 1 mg/cm^2 or more of lead regardless of its condition or location.

‡Includes locations such as household items not listed on the MDHSS sampling form.